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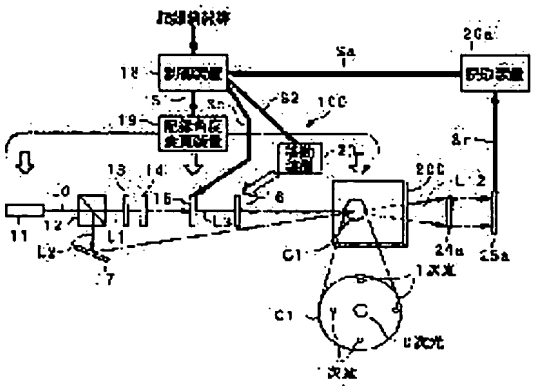
(54) HOLOGRAM RECORDING DEVICE AND METHOD OF ANGLE MULTIPLE TYPE AND HOLOGRAM RECONSTRUCTING DEVICE AND METHOD

(57)Abstract:
PROBLEM TO BE SOLVED: To improve the recording density and recording capacity in hologram recording and reconstructing and to exactly and rapidly perform a recording operation and reconstructing operation.
SOLUTION: The hologram recording device (100) is provided with recording angle changing means (19) capable of relatively changing the recording angle of a hologram recording medium (200) with respect to signal light (L3) and reference light (L2) and control means (18). The control means sets the recording angle in recording a specific angle recording surface among a plurality of angle recording surfaces of the hologram recording medium as a reference recording angle. Further, the recording angle changing means is so controlled that the subsequent recording angle is changed and fixed by the prescribed angle each on the basis of the set reference recording angle.



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CLAIMS

[Claim(s)]
[Claim 1] The light source which irradiates light source light, and the 1st optical system which divides the light source light this irradiated into signal light and a reference beam, It is arranged at the optical path of said signal light. The space optical modulator which can modulate said signal light, The 2nd optical system which draws the signal light which passed this space optical modulator, and said reference beam on a hologram record medium, Relatively the record include angle of said hologram record medium to said signal light and said reference beam The record include-angle modification means which can be changed, Said record include angle at the time of recording a specific include-angle recording surface among two or more include-angle recording surfaces which can be set to said hologram record medium is set up as a criteria record include angle. The hologram recording device of the include-angle multiplex mold characterized by having the control means which controls said record include-angle modification means to change said subsequent record include angles a predetermined include angle every on the basis of said set-up criteria record include angle, and to fix.
[Claim 2] Said space optical modulator is the include-angle multiplex type according to claim 1 characterized by recording the include-angle criteria identification information which shows the purport which is a criteria include-angle recording surface corresponding to said criteria record include angle to said specific include-angle recording surface when said hologram record medium has not been recorded of hologram recording device.
[Claim 3] Said control means is a hologram recording device according to claim 2 characterized by proofreading said record include-angle modification means based on said include-angle criteria identification information to said hologram record medium after recording information was recorded to said specific include-angle recording surface at least.
[Claim 4] It is the hologram recording device according to claim 1 which the include-angle criteria identification information which shows the purport which is a criteria include-angle recording surface corresponding to said criteria record include angle is recorded on one of two or more include-angle recording surfaces which can be set to said hologram record medium, and is characterized by said control means proofreading said record include-angle modification means based on said include-angle criteria identification information.
[Claim 5] The hologram recording device of an include-angle multiplex mold given in any 1 term of claims 1-4 characterized by having further the migration means to which said hologram record medium is moved relatively to the condensing location of said signal light drawn according to said 2nd optical system, and said reference beam.
[Claim 6] Said space optical modulator is the include-angle multiplex type according to claim 5 characterized by performing record of as opposed to all the include-angle recording surfaces of said hologram record medium the whole migration by said migration means of hologram recording device.
[Claim 7] Said specific include-angle recording surface is the hologram recording device of an include-angle multiplex mold given in any 1 term of claims 1-6 characterized by being the include-angle recording surface first recorded among said two or more include-angle recording surfaces.
[Claim 8] It is the hologram regenerative apparatus which reproduces recording information from the hologram record medium of the include-angle multiplex mold with which the include-angle criteria identification information which shows the purport which is a criteria include-angle recording surface is recorded on one of two or more include-angle recording surfaces. The light source which irradiates the playback illumination light at said hologram record medium, and a light-receiving means to receive the playback light based on said playback illumination light from said hologram record medium, A reading

means to read said two or more recording information recorded on said hologram record medium in piles based on the received this playback light, respectively, Relatively the playback include angle of said hologram record medium to said playback illumination light The playback include-angle modification means which can be changed, It has the control means which controls said playback include-angle modification means to make change a predetermined include angle every on the basis of the criteria playback include angle corresponding to said criteria include-angle recording surface said playback include angle and fix. Said control means is a hologram regenerative apparatus characterized by proofreading said playback include-angle modification means based on said include-angle criteria identification information.
[Claim 9] The include-angle multiplex type according to claim 8 characterized by having further the migration means to which said hologram record medium is moved relatively to the condensing location of said playback illumination light of hologram regenerative apparatus.
[Claim 10] The aforementioned reading means is the include-angle multiplex type according to claim 9 characterized by performing playback of as opposed to all the include-angle recording surfaces of said hologram record medium the whole migration by said migration means of hologram regenerative apparatus.
[Claim 11] The light source which irradiates light source light, and the 1st optical system which divides the light source light this irradiated into signal light and a reference beam, It is arranged at the optical path of said signal light. The space optical modulator which can modulate said signal light, The 2nd optical system which draws the signal light which passed this space optical modulator, and said reference beam on a hologram record medium, It is the hologram record approach by the hologram recording device of the include-angle multiplex mold relatively equipped with the record include-angle modification means which can be changed for the record include angle of said hologram record medium to said signal light and said reference beam. The process which sets up said record include angle at the time of recording a specific include-angle recording surface among two or more include-angle recording surfaces which can be set to said hologram record medium as a criteria record include angle, The hologram record approach of the include-angle multiplex mold characterized by having the process which controls said record include-angle modification means to change said subsequent record include angles a predetermined include angle every on the basis of said set-up criteria record include angle, and to fix.
[Claim 12] Said specific include-angle recording surface is the include-angle multiplex type according to claim 11 characterized by being the include-angle recording surface first recorded among said two or more include-angle recording surfaces of the hologram record approach.
[Claim 13] It is the hologram regenerative apparatus which reproduces recording information from the hologram record medium of the include-angle multiplex mold with which the include-angle criteria identification information which shows the purport which is a criteria include-angle recording surface is recorded on one of two or more include-angle recording surfaces. The light source which irradiates the playback illumination light at said hologram record medium, and a light-receiving means to receive the playback light based on said playback illumination light from said hologram record medium, A reading means to read said two or more recording information recorded on said hologram record medium in piles based on the received this playback light, respectively, In the hologram playback approach by the hologram regenerative apparatus of the include-angle multiplex mold relatively equipped with the playback include-angle modification means which can be changed for the playback include angle of said hologram record medium to said playback illumination light The process which proofreads said playback include-angle modification means based on said include-angle criteria identification information, The hologram playback approach of the include-angle multiplex mold characterized by including the process which controls said playback include-angle modification means to make change a predetermined include angle every on the basis of the criteria playback include angle corresponding to said criteria include-angle recording surface said playback include angle and fix.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention irradiates signal light through a space optical modulator (Spatial Light Modulator) at a hologram record medium, and belongs to the technical field of the hologram regenerative apparatus which reproduces information from this hologram record medium in the hologram recording device and approach list which record information, and an approach. Multiplex record of the recording information which is different in the same area by changing relatively the include angle to the front face of the hologram record medium of a reference beam and signal light especially is carried out, and it belongs to the hologram recording device and approach list of an include-angle multiplex mold which reproduce this at the technical field of a hologram regenerative apparatus and an approach.
[0002]
[Description of the Prior Art] Conventionally, in a hologram recording device, it consists of liquid crystal equipment etc., for example, and a signal light slack laser beam is irradiated by the space optical modulator which becomes irregular according to the recording information which should be recorded. The flat-surface array of the cel is carried out at the shape of a matrix, and especially a space optical modulator is changing light transmittance according to recording information for every cel, and modulates signal light here. Furthermore, outgoing radiation of the modulated signal light is carried out at a different outgoing radiation include angle by the diffraction phenomena in a cel with a detailed pitch as two or more diffracted lights, such as zero-order light and primary light. Under the present circumstances, an outgoing radiation include angle is prescribed by the pitch of the cel which is a modulation unit. And the signal light modulated by the space optical modulator constituted in this way and the reference beam which does not pass through a space optical modulator are made to interfere on a hologram record medium. Thereby, it is constituted so that recording information may be recorded on a hologram record medium as a wave front.
[0003] The hologram recording device of the include-angle multiplex mold which carries out multiplex record of the recording information which is different in the same area is also proposed by changing the include angle of the front face of the hologram record medium to a reference beam and signal light small [every] especially at the time of record. In this application, the include angle of the signal light to the front face of a hologram record medium in record of such an include-angle multiplex mold is suitably called a "record include angle." Furthermore, include angles used as the criteria of a record include angle, such as a record include angle at the time of being in agreement with the normal of the front face of a hologram record medium, for example, are suitably called a "criteria record include angle." Furthermore, by this application, the recording surface corresponding to a "include-angle recording surface", a call, and a criteria record include angle for the recording surface corresponding to each record include angle will be called a "criteria include-angle recording surface" again.
[0004] On the other hand, by changing the include angle of the front face of the hologram record medium to the playback illumination light small [every], a such hologram recording device and the hologram regenerative apparatus which makes a pair are constituted so that the recording information by which multiplex record was carried out may be reproduced in the same area. In this application, the include angle of the playback illumination light to the front face of a hologram record medium in playback of such an include-angle multiplex mold is suitably called a "playback include angle." Furthermore, include angles used as the criteria of a playback include angle, such as a playback include angle at the time of being in agreement with the normal of the front face of a hologram record medium, for example, are suitably called a "criteria playback include angle."
[0005] According to the hologram recording device of an include-angle multiplex mold, a record include

angle is changed in the range of whenever [maximum number] for example, by unit 0.01 degrees from a criteria record include angle (changing small [every] among 88 - 92 degrees), and record over each include-angle recording surface in the same record area is performed one by one for every record include angle. In addition, in this application, the field on the front face of the hologram record medium with which signal light and a reference beam are irradiated at a stretch will be called "record area." In the case of an include-angle multiplex mold, two or more include-angle recording surfaces which it said were the 50th page will be recorded on the same record area.

[0006] On the other hand, according to the hologram regenerative apparatus of an include-angle multiplex mold, the recording information by which multiplex record was carried out is reproduced according to a playback include angle in the same area by changing a playback include angle slightly corresponding to the case of a criteria playback include angle to a record include angle.

[0007] Thus, since according to the hologram recording device and hologram regenerative apparatus of an include-angle multiplex mold recording information can be recorded on the include-angle recording surface of a large number recorded on the same area according to a record include angle, respectively and this can be reproduced, respectively, recording density and storage capacity shall be increased by leaps and bounds.

[0008]

[Problem(s) to be Solved by the Invention] However, generally in hologram record, include-angle selectivity is dramatically large. For this reason, it is the same model, and when performing the record (postscript) and the playback to the same hologram record medium (for example, removable record medium) using another hologram recording device, a hologram record regenerative apparatus, or a hologram regenerative apparatus, the mechanical condition or the setups at the time of fixing the hologram record medium concerned in each equipment by the variation between equipment at an above-mentioned criteria record include angle or an above-mentioned criteria playback include angle, such as a device and optical system, are not necessarily in agreement between each equipment. The criteria include-angle recording surface recorded as a thing corresponding to a criteria record include angle with the equipment of 1 depending on the variation between equipment stops for example, corresponding to a mechanical condition or setups, such as a device in which it should correspond to other criteria record include angles or criteria playback include angles in equipment, and optical system, actually. That is, under such a mechanical condition or setups, the include-angle recording surface from which a criteria include-angle recording surface differs may be taken for it being a criteria include-angle recording surface. Or the technical issue point that it may record on the include-angle recording surface which differs from the include-angle recording surface which it is going to record (postscript) according to misconception of a criteria include angle, or a different include-angle recording surface from the include-angle recording surface which it is going to reproduce may be reproduced, or it may lapse into playback impossible since a response with a record include angle and a playback include angle cannot be taken arises.

[0009] It is possible for this invention to be made in view of the trouble mentioned above, and to raise recording density and storage capacity, and let it be a technical problem to provide with a hologram regenerative apparatus and an approach the hologram recording device and approach list of accuracy and the include-angle multiplex mold which can perform record actuation and playback actuation promptly moreover.

[0010]

[Means for Solving the Problem] In order that the hologram recording device of the include-angle multiplex mold of this invention may solve the above-mentioned technical problem The light source which irradiates light source light, and the 1st optical system which divides the light source light this irradiated into signal light and a reference beam, It is arranged at the optical path of said signal light. The space optical modulator which can modulate said signal light, The 2nd optical system which draws the signal light which passed this space optical modulator, and said reference beam on a hologram record medium, Relatively the record include angle of said hologram record medium to said signal light and said reference beam The record include-angle modification means which can be changed, Said record include angle at the time of recording a specific include-angle recording surface among two or more include-angle recording surfaces which can be set to said hologram record medium is set up as a criteria record include angle. It has the control means which controls said record include-angle modification means to change said subsequent record include angles a predetermined include angle every on the basis of said set-up criteria record include angle, and to fix.

[0011] According to the hologram recording device of this invention, at the time of the actuation, the light source of semiconductor laser equipment etc. irradiates light source light, such as a laser beam. The 1st

optical system divides this light source light into signal light and a reference beam. Here, the space optical modulator which has been arranged, for example, is constituted from liquid crystal equipment etc. by the optical path of signal light performs the modulation to signal light. Then, the 2nd optical system draws this modulated signal light and the reference beam separated by the 1st optical system on a hologram record medium. Consequently, on a hologram record medium, recording information is recorded by interference with these signals light and a reference beam as a wave front.

[0012] Under the present circumstances, especially a control means sets up the record include angle [in / a hologram record medium] at the time of recording specific include-angle recording surfaces, such as the first include-angle recording surface, as a criteria record include angle. And under control by the control means, a record include-angle modification means changes the record include angle after recording the specific include-angle recording surface a predetermined include angle every on the basis of this set-up criteria record include angle, and is fixed. Therefore, it becomes possible to make in agreement the criteria record include angle specified by a mechanical condition or setups, such as a record include-angle modification means by the side of the hologram recording device concerned and optical system, and the criteria record include angle by the side of a hologram record medium at the time of the specific records at the time of the first record etc. That is, it is the same model about these, and also when using any of another hologram recording apparatus, the thing by the variation between equipment made in agreement [**] about each hologram recording apparatus at the time of specific record becomes possible. And record to an include-angle recording surface can be performed to accuracy also about which record include angle after it on the basis of the criteria record include angle set up about each hologram recording device at the time of specific record.

[0013] The include-angle information which shows the record include angle according to an include-angle recording surface is beforehand recorded on the hologram record medium here for the comparison, and in case the record (postscript) and the playback to each include-angle recording surface are performed, after checking whether record (postscript) over which include-angle recording surface and playback are performed by referring to this include-angle information first at each time of include-angle modification, the case where actual record (postscript) and playback are performed is assumed. In this case, since the activity which checks whether it is which include-angle recording surface at each time which changes a record include angle occurs, quick record actuation becomes difficult. Furthermore, the storage capacity of the part which records such include-angle information etc. for recording information to record actually [the other contents information etc.] will decrease.

[0014] On the other hand, subsequent quick include-angle modification and the record actuation of the hologram recording device of this invention are attained on the basis of the criteria record include angle set up at the time of specific record.

[0015] Thus, according to this invention, include-angle multiplex can raise recording density and storage capacity by leaps and bounds, multiplex record of an include-angle multiplex mold can be performed to accuracy, without moreover being based on the variation between equipment, and quick record actuation also becomes possible.

[0016] In addition, in this invention, a space optical modulator may carry out a binary modulation according to the binary data which recording information shows. Thereby, it is high-density and the recording information which shows binary data can be recorded on a hologram record medium. Or multi-level modulation may be carried out according to the gradation data which recording information shows. Thereby, it is high-density and the recording information which shows gradation data can be recorded on a hologram record medium.

[0017] Furthermore, in this invention, the signal light after the modulation by which outgoing radiation is carried out from a space optical modulator consists of at least one of the zero-order light by diffraction, and the Lth light (however, L, one or more natural numbers). For example, among the diffracted lights, using only zero-order light, using high order light, such as zero-order light, 1, or two or more primary light, it is high-density and hologram record is attained.

[0018] In addition, the hologram recording device of the include-angle multiplex mold of this invention mentioned above is received. The reference beam phase multiplex system which changes the phase of a reference beam and performs multiplex record, the reference beam amplitude multiplex system which changes the amplitude of a reference beam and performs multiplex record, At least one method may be combined among the reference beam polarization multiplex system which changes polarization of a reference beam and performs multiplex record, and the depth of focus multiplex system which changes into a hologram record medium the depth of focus of the signal light which carries out incidence, and performs

multiplex record. Hologram record of high density is attained thereby much more.
[0019] In one mode of the hologram recording device of the include-angle multiplex mold of this invention, said space optical modulator records the include-angle criteria identification information which shows the purport which is a criteria include-angle recording surface corresponding to said criteria record include angle to said specific include-angle recording surface, when said hologram record medium has not been recorded.
[0020] According to this mode, when a hologram record medium has not been recorded, a space optical modulator records include-angle criteria identification information to a specific include-angle recording surface. Therefore, based on this include-angle criteria identification information, it can recognize easily that the criteria record include angle is already set up to the hologram record medium concerned, and it becomes [whether which include-angle recording surface is a criteria include-angle recording surface and] identifiable easily after that, without asking the difference of a hologram recording device.
[0021] In other modes of the hologram recording device of the include-angle multiplex mold of this invention, said control means proofreads said record include-angle modification means based on said include-angle criteria identification information to said hologram record medium after recording information was recorded to said specific include-angle recording surface at least.
[0022] In case according to this mode recording information is recorded to other include-angle recording surfaces after recording to a specific include-angle recording surface, a control means proofreads a record include-angle modification means based on include-angle criteria identification information first. Detecting the angular difference of the include-angle recording surface corresponding to setups, such as a mechanical condition that it should correspond to the criteria record include angle in the record include-angle modification means in the event of more specifically, for example, this time, recording, or optical system, and the criteria include-angle recording surface shown by include-angle criteria identification information, only the this detected angular difference imposes offset and a record include-angle modification means changes a record include angle. Thereby, even if loading of a change of setups, such as a mechanical condition or optical system, with time and a hologram record medium or change of a setting include angle is large to extent which cannot be disregarded compared with the include-angle selectivity of a hologram record medium, such change is compensated by offset and recording information can be recorded on accuracy also to which include-angle recording surface (postscript).
[0023] Or in other modes of the hologram recording device of the include-angle multiplex mold of this invention, on one of two or more include-angle recording surfaces which can be set to said hologram record medium, the include-angle criteria identification information which shows the purport which is a criteria include-angle recording surface corresponding to said criteria record include angle is recorded, and said control means proofreads said record include-angle modification means based on said include-angle criteria identification information.
[0024] In case it records to the hologram record medium which has the include-angle recording surface on which record was already performed and include-angle criteria identification information was recorded according to this mode, a control means proofreads a record include-angle modification means based on include-angle criteria identification information. The angular difference of the include-angle recording surface corresponding to setups, such as a mechanical condition that it should correspond to the criteria record include angle in the record include-angle modification means in the event of more specifically, for example, this time, recording, or optical system, and the criteria include-angle recording surface shown by include-angle criteria identification information is detected, only the this detected angular difference imposes offset henceforth, and a record include-angle modification means changes a record include angle, and is fixed. Even if setups, such as a mechanical condition in a record include-angle modification means or optical system, are not in agreement between the hologram recording devices which are going to record by this other hologram recording devices which recorded on the criteria include-angle side first, and this time, such a difference is compensated by offset and recording information can be recorded on accuracy with the hologram recording device which is going to record this time (postscript).
[0025] In other modes of the hologram recording device of the include-angle multiplex mold of this invention, it has further the migration means to which said hologram record medium is moved relatively to the condensing location of said signal light drawn according to said 2nd optical system, and said reference beam.
[0026] When the record over 1 or two or more include-angle recording surfaces by the include-angle multiplex to one record area where signal light and a reference beam are condensed is completed according to this mode, as for a migration means, a hologram record medium is moved relatively. thereby, signal light

and a reference beam condense in other record area -- having -- being concerned -- others -- record over two or more include-angle recording surfaces is similarly performed to record area.
[0027] Said space optical modulator may consist of this mode so that record of as opposed to all the include-angle recording surfaces of said hologram record medium the whole migration by said migration means may be performed.
[0028] Thus, if constituted, it will become possible to stop small the count and movement magnitude of migration by the migration means. Furthermore, it also becomes possible to suppress the change in a mechanical condition or setups, such as a record include-angle modification means which may be generated with migration by the migration means, and optical system, to the minimum.
[0029] In addition, before completing the record over all the include-angle recording surfaces in the record area of 1, migration by the migration means may be performed. Or whenever it completes the record over the include-angle recording surface of 1 in the record area of 1, it is also possible to perform migration by the migration means.
[0030] In other modes of the hologram recording device of the include-angle multiplex mold of this invention, said specific include-angle recording surface is an include-angle recording surface first recorded among said two or more include-angle recording surfaces.
[0031] According to this mode, the record include angle at the time of recording the first include-angle recording surface in a hologram record medium is set up as a criteria record include angle. Therefore, record to an include-angle recording surface can be performed to accuracy also about which record include angle on the basis of the criteria record include angle set up at the time of the first record.
[0032] In order that the hologram regenerative apparatus of the include-angle multiplex mold of this invention may solve the above-mentioned technical problem It is the hologram regenerative apparatus which reproduces recording information from the hologram record medium of the include-angle multiplex mold with which the include-angle criteria identification information which shows the purport which is a criteria include-angle recording surface is recorded on one of two or more include-angle recording surfaces. The light source which irradiates the playback illumination light at said hologram record medium, and a light-receiving means to receive the playback light based on said playback illumination light from said hologram record medium, A reading means to read said two or more recording information recorded on said hologram record medium in piles based on the received this playback light, respectively, Relatively the playback include angle of said hologram record medium to said playback illumination light The playback include-angle modification means which can be changed, It has the control means which controls said playback include-angle modification means so that it may make change a predetermined include angle every on the basis of the criteria playback include angle corresponding to said criteria include-angle recording surface said playback include angle and fix, and said control means proofreads said playback include-angle modification means based on said include-angle criteria identification information.
[0033] According to the hologram regenerative apparatus of the include-angle multiplex mold of this invention, at the time of the actuation, the light source of semiconductor laser equipment etc. irradiates playback illumination light, such as a laser beam. Then, the light-receiving means which comes to contain a photodiode array, CCD (Charge Coupled Device), etc., for example receives the playback light based on the playback illumination light from a hologram record medium. They are high order light, such as zero-order light produced when the playback illumination light corresponding to the reference beam [here / "light / playback"] at the time of record is irradiated by the hologram record medium, or primary light, etc. Then, based on the playback light received by this light-receiving means, a reading means reads two or more recording information recorded on each include-angle recording surface according to an include-angle recording surface.
[0034] Under the present circumstances, especially a control means proofreads a playback include-angle modification means based on the include-angle criteria identification information read in a hologram record medium. And under control by the control means, a playback include-angle modification means changes each playback include angle a predetermined include angle every on the basis of a criteria playback include angle, and is fixed. The angular difference of the include-angle recording surface corresponding to setups, such as a mechanical condition that it should correspond to the criteria playback include angle in the playback include-angle modification means in the event of more specifically, for example, this time, reproducing, or optical system, and the criteria include-angle recording surface shown by include-angle criteria identification information is detected, only the this detected angular difference imposes offset henceforth, and a playback include-angle modification means changes a playback include angle, and is fixed. Even if setups, such as a mechanical condition in a record include-angle modification means and a

playback include-angle modification means or optical system, are not in agreement between the hologram regenerative apparatus which are going to record by this other hologram recording devices which recorded on the criteria include-angle recording surface first, and this time, such a difference is compensated by offset and recording information can be reproduced to accuracy with the hologram regenerative apparatus which it is going to reproduce this time.

[0035] The include-angle information which shows the record include angle according to an include-angle recording surface is beforehand recorded on the hologram record medium here for the comparison, and in case playback to each include-angle recording surface is performed, after checking whether playback to which include-angle recording surface is performed by referring to this include-angle information first at each time of include-angle modification, the case where actual playback is performed is assumed. In this case, since the activity which checks whether it is which include-angle recording surface at each time which changes a playback include angle occurs, quick playback actuation becomes difficult.

[0036] On the other hand, the hologram regenerative apparatus of this invention is proofreading based on include-angle criteria identification information, and subsequent quick include-angle modification and the playback actuation of it are attained.

[0037] Thus, according to this invention, include-angle multiplex can raise recording density and storage capacity by leaps and bounds, an include-angle multiplex mold can be reproduced to accuracy, without moreover being based on the variation between equipment, and quick playback actuation also becomes possible.

[0038] In addition, the hologram regenerative apparatus of the include-angle multiplex mold of this invention mentioned above is received. The reference beam phase multiplex system which changes the phase of a reference beam and performs multiplex record, the reference beam amplitude multiplex system which changes the amplitude of a reference beam and performs multiplex record, At least one method may be combined among the reference beam polarization multiplex system which changes polarization of a reference beam and performs multiplex record, and the depth of focus multiplex system which changes into a hologram record medium the depth of focus of the signal light which carries out incidence, and performs multiplex record. Hologram playback of high density is attained thereby much more.

[0039] In other modes of the hologram regenerative apparatus of this invention, it has further the migration means to which said hologram record medium is moved relatively to the condensing location of said playback illumination light.

[0040] When the playback to 1 or two or more include-angle recording surfaces by the include-angle multiplex to one record area where the playback illumination light is condensed is completed according to this mode, as for a migration means, a hologram record medium is moved relatively. thereby, the playback illumination light condenses in other record area -- having -- being concerned -- others -- playback to two or more include-angle recording surfaces is similarly performed to record area.

[0041] The aforementioned reading means may consist of this mode so that playback of as opposed to all the include-angle recording surfaces of said hologram record medium the whole migration by said migration means may be performed.

[0042] Thus, if constituted, it will become possible to stop small the count and movement magnitude of migration by the migration means. Furthermore, it also becomes possible to suppress the change in a mechanical condition or setups, such as a playback include-angle modification means which may be generated with migration by the migration means, and optical system, to the minimum.

[0043] In addition, before completing the playback to all the include-angle recording surfaces in the record area of 1, migration by the migration means may be performed. Or whenever it completes the playback to the include-angle recording surface of 1 in the record area of 1, it is also possible to perform migration by the migration means.

[0044] In order that the hologram record approach of the include-angle multiplex mold of this invention may solve the above-mentioned technical problem The light source which irradiates light source light, and the 1st optical system which divides the light source light this irradiated into signal light and a reference beam, It is arranged at the optical path of said signal light. The space optical modulator which can modulate said signal light, The 2nd optical system which draws the signal light which passed this space optical modulator, and said reference beam on a hologram record medium, It is the hologram record approach by the hologram recording device of the include-angle multiplex mold relatively equipped with the record include-angle modification means which can be changed for the record include angle of said hologram record medium to said signal light and said reference beam. The process which sets up said record include angle at the time of recording a specific include-angle recording surface among two or more include-angle recording surfaces

which can be set to said hologram record medium as a criteria record include angle, It has the process which controls said record include-angle modification means to change said subsequent record include angles a predetermined include angle every on the basis of said set-up criteria record include angle, and to fix.
[0045] According to the hologram record approach of the include-angle multiplex mold of this invention, like the case of the hologram recording device of this invention mentioned above, include-angle multiplex can raise recording density and storage capacity by leaps and bounds, multiplex record of an include-angle multiplex mold can be performed to accuracy, without moreover being based on the variation between equipment, and quick record actuation also becomes possible.
[0046] In one mode of the hologram record approach of the include-angle multiplex mold of this invention, said specific include-angle recording surface is an include-angle recording surface first recorded among said two or more include-angle recording surfaces.
[0047] According to this mode, the record include angle at the time of recording the first include-angle recording surface in a hologram record medium is set up as a criteria record include angle. Therefore, record to an include-angle recording surface can be performed to accuracy also about which record include angle on the basis of the criteria record include angle set up at the time of the first record.
[0048] In order that the hologram playback approach of the include-angle multiplex mold of this invention may solve the above-mentioned technical problem It is the hologram regenerative apparatus which reproduces recording information from the hologram record medium of the include-angle multiplex mold with which the include-angle criteria identification information which shows the purport which is a criteria include-angle recording surface is recorded on one of two or more include-angle recording surfaces. The light source which irradiates the playback illumination light at said hologram record medium, and a light-receiving means to receive the playback light based on said playback illumination light from said hologram record medium, A reading means to read said two or more recording information recorded on said hologram record medium in piles based on the received this playback light, respectively, In the hologram playback approach by the hologram regenerative apparatus of the include-angle multiplex mold relatively equipped with the playback include-angle modification means which can be changed for the playback include angle of said hologram record medium to said playback illumination light The process which proofreads said playback include-angle modification means based on said include-angle criteria identification information, and the process which controls said playback include-angle modification means to make change a predetermined include angle every on the basis of the criteria playback include angle corresponding to said criteria include-angle recording surface said playback include angle and fix are included.
[0049] According to the hologram playback approach of the include-angle multiplex mold of this invention, like the case of the hologram regenerative apparatus of this invention mentioned above, include-angle multiplex can raise recording density and storage capacity by leaps and bounds, an include-angle multiplex mold can be reproduced to accuracy, without moreover being based on the variation between equipment, and quick playback actuation also becomes possible.
[0050] Such an operation and other gains of this invention will be made clear from the gestalt of the operation explained below.
[0051]
[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained based on a drawing.
[0052] (The 1st operation gestalt of a hologram recording device) The 1st operation gestalt of the hologram recording device of this invention is explained with reference to drawing 3 from drawing 1 .
[0053] First, with reference to drawing 1 and drawing 2 , the whole hologram recording device configuration concerning this operation gestalt is explained. It is the block diagram showing the whole hologram recording apparatus configuration which drawing 1 requires for this operation gestalt here. Drawing 2 is the graph appearance perspective view of the space optical modulator with which this operation gestalt was equipped.
[0054] As shown in drawing 1 , the hologram recording device 100 concerning this operation gestalt Example slack laser equipment 11 of the light source which irradiates the light source light L0 which consists of a laser beam, An example slack beam splitter 12 of the 1st optical system which divides this light source light L0 into the signal light L1 and a reference beam L2, The lens 13 which constitutes an example of amplification optical system which is arranged at the optical path of the signal light L1, and expands the path of the signal light L1, The lenses 14, such as a collimator lens which makes parallel light signal light L1 by which outgoing radiation was carried out from the lens 13 in general, The space optical modulator 15 which becomes irregular according to the record signal which should be recorded, and carries out outgoing

radiation of the signal light L1 by which outgoing radiation was carried out from the lens 14 as a signal light L3 after a modulation, and the path of the signal light L3 are reduced, and it has an example slack lens 16 of the cutback optical system which carries out outgoing radiation towards the hologram record medium 200.
[0055] Furthermore, the hologram recording apparatus 100 is equipped with an example slack mirror 17 of the 2nd optical system which leads the reference beam L2 separated by the beam splitter 12 to the same location as the location where the signal light L3 corresponding to the reference beam L2 concerned on the hologram record medium 200 is condensed.
[0056] In addition, the surface part C1 by which the signal light L3 containing the zero-order light and four primary light which it comes to diffract by the space optical modulator 15 on the hologram record medium 200 is condensed is expanded, and drawing 1 has shown.
[0057] As shown in drawing 2 , the space optical modulator 15 consists for example, of liquid crystal equipment, is divided into two or more cels 152, and can be modulated in the unit of this cel 152. For example, if the space optical modulator 15 is liquid crystal equipment of a active-matrix actuation mold, corresponding to two or more pixel electrodes by which two-dimensional array was carried out, two or more cels 152 will be specified to the shape of a matrix. If incidence of the signal light L1 is carried out, the space optical modulator 15 is constituted by the diffraction phenomena according to the size of a cel 152 so that outgoing radiation of zero-order light L3-0 and the primary light 3-1, 2 order light L3-2, and the signal light L3 that consists of the modulated diffracted light containing high order light of -- may be carried out.
[0058] In drawing 1 , the hologram recording device 100 is again equipped with the record include-angle modification equipment 19 which can change the include angle of the signal light L3 to the front face of the hologram record medium 200, and a reference beam L2 small [every], and can fix it, and the control unit 18 which controls record include-angle modification equipment 19 so that the signal light L3 serves as a record include angle corresponding to the include-angle recording surface in the hologram record medium 200 which should be recorded. In addition, this operation gestalt defines the include angle which the optical axis of the signal light L3 makes to the front face of the hologram record medium 200 as a "record include angle."
[0059] Record include-angle modification equipment 19 the record include angle of the signal light L3 to the front face of the hologram record medium 200 that what is necessary is just to change relatively For example, may be constituted so that the include angle and arrangement to each optical axis of the space optical modulator 15 may be changed into the laser equipment 11 and the beam splitter 12 which make optical system, lenses 13, 14, and 16, and a list, and this optical system is received. Additional arrangement of the optical element of dedication which changes the include angle of the signal light L3 or a reference beam L2 may be carried out. Or it may be constituted so that the maintenance include angle of the hologram record medium 200 may be mechanically replaced with or changed into this in addition. About the include-angle modification actuation by the record include-angle modification equipment 19 to apply, it is controlled to make a part of a series of record actuation mentioned later with a control unit 18.
[0060] A control unit 18 supplies the record signal Sd according to recording information to a space optical modulator 15, and it is constituted so that the modulation in the space optical modulator 15 may control, while carrying out the generation output of the control signal S1 according to the recording information which should be recorded on the hologram record medium 200 coming [the controller which consists of a microprocessor] and controlling the record include angle in record include-angle modification equipment 19 like ****.
[0061] Lens 24a to which the hologram recording device 100 condenses the playback light L12 based on the playback illumination light from the hologram record medium 200 further, Light-receiving equipment 25a which receives the playback light L12 through this lens 24a, Based on the received this playback light L12, it has reader 26a which reads two or more recording information recorded on the hologram record medium 200 in piles, respectively based on the light-receiving signal Sr outputted from light-receiving equipment 25a.
[0062] By intercepting the signal light L1 or L3 in one before resulting in the hologram record medium 200 of phases, it consists of these operation gestalten so that a reference beam L2 may be used as playback illumination light as it is. For example, the signal light L1 or L3 can be intercepted in this way by using the space optical modulator 15 under control by the control unit 18 as a shutter which intercepts the signal light L1. Or the configuration which carries out additional arrangement of the optical element of dedication at the signal light L1 or the optical path of L3 in order to intercept the signal light L1 or L3, and the configuration which inserts a protection-from-light member in the signal light L1 or the optical path of L3 selectively may be adopted.

[0063] Thus, light-receiving equipment 25a which receives the playback light L12 generated through lens 24a comes to contain for example, a photodiode array, CCD (Charge Coupled Device), etc.
[0064] Reader 26a is specifying the recording information corresponding to the light-and-darkness pattern of the received playback light L12, and reads each recording information. With especially this operation gestalt, reading of the criteria include-angle recording surface in which the include-angle reference signal Sa as an example of the identification information which shows the purport which is a criteria include-angle recording surface corresponding to a criteria record include angle among two or more include-angle recording surfaces which can be set to the hologram record medium 200 was written to the include-angle reference signal Sa concerned is possible for reader 26a. And if the include-angle reference signal Sa is read in this way, reader 26a is constituted so that this may be outputted to a control unit 18.
[0065] Especially with this operation gestalt, a control unit 18 sets up the record include angle at the time of recording the first include-angle recording surface as a specific include-angle recording surface in the hologram record medium 200 as a criteria record include angle. And record include-angle modification equipment 19 is constituted so that the record include angle after recording the first include-angle recording surface may be changed a predetermined include angle every on the basis of this set-up criteria record include angle and it may fix under control by the control unit 18.
[0066] Furthermore, a control unit 18 controls the space optical modulator 15 to record the include-angle reference signal Sa which shows the purport which is a criteria include-angle recording surface corresponding to a criteria record include angle to this first include-angle recording surface in addition to setting up the first include-angle recording surface as a criteria include-angle recording surface, when judged [having not recorded the hologram record medium 200 by the existence of the include-angle reference signal Sa from reader 26a, and]. It can recognize easily that the criteria record include angle is already set up to the hologram record medium 200 after that based on this include-angle reference signal Sa. Furthermore, the difference of the hologram record medium 200 or the difference of the hologram recording device 100 can be easily identified for whether which include-angle recording surface is a criteria include-angle recording surface using reader 26a, without asking.
[0067] Furthermore, a control unit 18 proofreads record include-angle modification equipment 19 again based on the criteria record include angle shown by the include-angle reference signal Sa to the hologram record medium 200 after recording information was recorded to the first include-angle recording surface. That is, in case the first include-angle recording surface is recorded, while setting this up as a criteria include-angle recording surface, a calibration shall not be applied to record include-angle modification equipment 19. And behind, in case the include-angle recording surface of arbitration is recorded, according to the criteria record include angle corresponding to the criteria include-angle recording surface shown by the include-angle reference signal Sa, it is constituted so that a calibration may be applied to record include-angle modification equipment 19. The angular difference of the record include angle in setups, such as a mechanical condition that it should correspond to the criteria record include angle in the record include-angle modification equipment 19 in the event of more specifically, for example, this time, recording, or optical system, and the criteria record include angle corresponding to the criteria include-angle recording surface shown by the include-angle reference signal Sa is detected. Furthermore, only this detected angular difference imposes offset, and record include-angle modification equipment 19 is constituted so that a record include angle may be changed.
[0068] Furthermore, similarly, when such an include-angle reference signal Sa is recorded on the hologram record medium 200 from the beginning by another hologram recording device again, the control unit 18 is constituted based on the criteria record include angle shown by this include-angle reference signal Sa so that record include-angle modification equipment 19 may be proofread.
[0069] In addition, the hologram recording device 100 is further equipped with the migration equipment 20 made to move the location where the signal light L3 and a reference beam L2 are condensed to the front face of the hologram record medium 200 in the direction which met the front face relatively. Migration equipment 20 moves the condensing location of the signal light L3 and a reference beam 2 by changing the include angle of the optical system of for example, lens 16 grade, and arrangement. Or you may move by changing the include angle of other optical elements of laser equipment 11 grade, and arrangement, and additional arrangement of the optical elements (for example, mirror whose installation include angle is adjustable) of the dedication for such migration may be carried out in the signal light L1 or L3 list at the optical path of a reference beam L2. Furthermore, you may also include the device to which hologram record-medium 200 the very thing is mechanically moved along the front face according to the maintenance device of the hologram record medium 200. Also about the migration actuation by the migration equipment

20 to apply, it is controlled by the control signal S2 by which a generation output is carried out with a control unit 18 to make a part of a series of record actuation mentioned later.
[0070] Next, with reference to drawing 1 , fundamental record actuation of the hologram recording device 100 of this constituted operation gestalt is explained like the above.
[0071] At the time of the actuation, laser equipment 11 irradiates the light source light L0, and a beam splitter 12 divides the light source light L0 into the signal light L1 and a reference beam L2. And incidence is carried out to the space optical modulator 15, signal light L1 being used as the path according to the size of the space optical modulator 15 with lenses 13 and 14. Then, the space optical modulator 15 performs the modulation to the signal light L1 by making each cel 152 into a modulation unit under control by the control unit 18 according to each of two or more recording information which should be recorded. Then, this modulated signal light L3 is irradiated by the record section of the hologram record medium 200 with the reference beam L2 reflected by the mirror 17, after being condensed with a lens 16. Then, it interferes in such light mutually and hologram record of the recording information which should be recorded is carried out as a wave front.
[0072] Record of the recording information over one include-angle recording surface corresponding to one record include angle in one record area where the signal light L3 and a reference beam L2 are irradiated at a stretch is performed by the above fundamental record actuation.
[0073] Next, the detail of record actuation of the include-angle multiplex mold in the hologram recording device 100 of this operation gestalt which performs such record to two or more include-angle recording surfaces, and performs it to further two or more record area is explained with reference to drawing 3 . It is the flow chart which shows the record actuation which drawing 3 requires here.
[0074] In drawing 3 , while the signal light L3 is intercepted first, a reference beam L2 is used as playback illumination light, and the playback light L12 is received by light-receiving equipment 25a. According to this, the include-angle reference signal Sa outputted from reader 26a is checked by the control device 18 (step S11). And according to the existence or nonexistence of the include-angle reference signal Sa, it is judged by the control unit 18 whether it is the first record over the hologram record medium 200 concerned (step S12).
[0075] Here, if it is the first record (step S12: Yes), while the signal light L3 and a reference beam L2 will be used, based on the record signal Sd which shows the include-angle reference signal Sa, modulation actuation by the space optical modulator 15 is performed, and the include-angle reference signal Sa is recorded. This record is performed to the include-angle recording surface, i.e., the criteria include-angle recording surface, in this event in the hologram record medium 200 (step S13).
[0076] On the other hand, if it is not the first record as a result of the judgment of step S12 (step S12: No), while the record include angle at present currently fixed by record include-angle modification equipment 19 will be checked, it is held at the internal memory of a control unit 18, for example (step S14). Furthermore, based on the angular difference of the criteria record include angle corresponding to the criteria include-angle recording surface shown by the include-angle reference signal Sa, and the record include angle in this condition of having been fixed, the calibration to record include-angle modification equipment 19 is performed (step S15). This calibration is performed by applying the offset according to above-mentioned angular difference to the control signal S1 inputted into record include-angle modification equipment 19.
[0077] It is judged by the control unit 18 to the include-angle recording surface at present in the record area (namely, field where the signal light L3 and a reference beam L2 are irradiated at present) in this time of the hologram record medium 200 fixed by migration equipment 20 fixed by record include-angle modification equipment 19 following step S13 or processing of S15 whether data logging of recording information is performed (step S16).
[0078] the case where data logging is not performed here -- (step S16:No) -- processing is ended as it is. That is, it means that it performed effectively in this case about the check (step S11) of the include-angle reference signal Sa, or record (step S13) of the include-angle reference signal Sa.
[0079] On the other hand, when performing data logging, while (step S16:Yes), the signal light L3, and a reference beam L2 are irradiated as a result of the judgment of step S16, according to the record signal Sd, the signal light L3 is modulated by the space optical modulator 15, and actual data logging is performed (step S17).
[0080] Then, it is judged by the control unit 18 to the following include-angle recording surface which can be changed with the record include-angle modification equipment 19 in the record area in this time of the hologram record medium 200 fixed by migration equipment 20 whether data logging of recording information is performed (step S18).

[0081] Here, when performing data logging to the following include-angle recording surface, in response to control by (step S18:Yes) and the control signal S1, only a minute include angle (for example, 0.01 degrees) predetermined in a record include angle is changed by record include-angle modification equipment 19 (step S19). Under the present circumstances, since the calibration on the basis of a criteria record include angle is performed in record include-angle modification equipment 19 like the above-mentioned, it is possible to change such a record include angle into accuracy. And it returns to step S16 and subsequent processings are repeated.

[0082] On the other hand, as a result of the judgment of step S18, when not performing data logging to the following include-angle recording surface, it is judged by the control unit 18 whether (step S18:No) and migration equipment 20 perform data logging of recording information to other movable record area (step S20).

[0083] Here, when performing data logging to other record area, the record include angle which changes with record include-angle modification equipment 19, and is fixed in response to control by (step S20:Yes) and the control signal S1 is reset. That is, a record include angle is changed by record include-angle modification equipment 19, and it is fixed so that it may become a record include angle corresponding to the first include-angle recording surface in the next record area (step S21). Under the present circumstances, since the calibration on the basis of a criteria record include angle is performed in record include-angle modification equipment 19 like the above-mentioned, it is possible to reset such a record include angle to accuracy, and it is also possible to also make a change of the record include angle after reset to accuracy further.

[0084] Then, in response to control by the control signal S2, only predetermined distance is moved by migration equipment 20 and let with it the fields where the signal light L3 and a reference beam L2 are irradiated be other record area (step S22). And it returns to step S16 and subsequent processings are repeated.

[0085] On the other hand, as a result of the judgment of step S20, in not performing data logging to other record area, it ends (step S20:No) and a series of record processings.

[0086] By the above, multiplex record of the recording information over two or more include-angle recording surfaces which can be set in two or more record area is completed.

[0087] As explained above, according to this operation gestalt, a control unit 18 sets up the record include angle at the time of recording the first include-angle recording surface in the hologram record medium 200 as a criteria record include angle. And under control by the control unit 18, predetermined changes the record include angle after recording the first include-angle recording surface a minute include angle every on the basis of this set-up criteria record include angle, and record include-angle modification equipment 19 is fixed. Therefore, it becomes possible to make in agreement the record include angle which must be equivalent to the criteria record include angle specified by a mechanical condition or setups, such as optical system which becomes the hologram recording apparatus 100 side 19, i.e., record include-angle modification equipment, and a list from laser equipment 11, a beam splitter 12, and lenses 13, 14, and 16, and the criteria record include angle by the side of the hologram record medium 200 at the time of the first record. That is, it is the same model about both [these] include angles, and also when using any of another hologram recording apparatus 100, it becomes possible to make it in agreement [without being based on the variation between equipment]. And after it, record to an include-angle recording surface can be performed to quick and accuracy also about which record include angle on the basis of a criteria record include angle.

[0088] As explained above, hologram record of an include-angle multiplex mold is possible for the hologram recording device 100 of this operation gestalt. However, while intercepting the signal light L1 or L3 with this operation gestalt, it is also possible by using a reference beam L2 as playback illumination light to reproduce the recording information of the arbitration by which multiplex record was carried out with include-angle multiplex system to the hologram record medium 200 using lens 24a, light-receiving equipment 25a, and reader 26a. In the configuration of the 1st operation gestalt shown in drawing 1 namely, in the time of record and playback The signal light L1 or L3 is intercepted. With and lens 24a, light-receiving equipment 25a, reader 26a, and a control unit 18 If it is made to perform the same playback actuation as the hologram regenerative apparatus of this invention mentioned later, the hologram recording device 100 of this operation gestalt can be built as a hologram record regenerative apparatus in which both record and playback are possible.

[0089] With the operation gestalt explained above, the space optical modulator 15 can also carry out multi-level modulation according to the gradation data which may carry out the binary modulation of the signal light L3 according to the shown binary data of recording information, and recording information shows.

[0090] In addition, as an ingredient of a hologram record medium, the ingredient of a well-known inorganic system is sufficient, and the ingredient (polymer ingredient) of an organic system is sufficient. Moreover, a hologram record medium may be constituted as a card-like medium, and may be constituted as a disk-like medium.

[0091] (The 2nd operation gestalt of a hologram recording device) The 2nd operation gestalt of the hologram recording device of this invention is explained with reference to drawing 4 . Drawing 4 is a flow chart which shows record actuation [in / here / the hologram recording apparatus of the 2nd operation gestalt].

[0092] Unlike the case of the 1st operation gestalt, with the 2nd operation gestalt, the timing of modification of an include-angle recording surface and modification of record area is the same as that of the case of the 1st operation gestalt about other configurations and actuation. So, in the flow chart of drawing 4 , the same step number is given to the step shown in drawing 3 , and the same step, and it omits suitably about those explanation.

[0093] In drawing 4 , processing of S17 is first performed from step S11 like the case of the 1st operation gestalt shown in drawing 3 .

[0094] It is judged by the control unit 18 whether after termination of step S17, migration equipment 20 performs data logging of recording information to other movable record area (step S31).

[0095] Here, when you perform data logging to other record area, in response to control by (step S31:Yes) and the control signal S2, only predetermined distance is moved by migration equipment 20 and let with it the fields where the signal light L3 and a reference beam L2 are irradiated be other record area (step S33). And it returns to step S16 and subsequent processings are repeated.

[0096] On the other hand, as a result of the judgment of step S31, when not performing data logging to other record area, it is judged by the control unit 18 to the following include-angle recording surface which can be changed with the record include-angle modification equipment 19 in the record area in this time of the hologram record medium 200 fixed by (step S20:No) and migration equipment 20 whether data logging of recording information is performed (step S34).

[0097] Here, when performing data logging to the following include-angle recording surface, in response to control by (step S34:Yes) and the control signal S1, only a minute include angle (for example, 0.01 degrees) predetermined in a record include angle is changed by record include-angle modification equipment 19 (step S35). Under the present circumstances, since the calibration on the basis of a criteria record include angle is performed in record include-angle modification equipment 19 like the above-mentioned, it is possible to change such a record include angle into accuracy. And it returns to step S16 and subsequent processings are repeated.

[0098] On the other hand, as a result of the judgment of step S34, in not performing data logging to the following include-angle recording surface, it ends (step S34:No) and a series of record processings.

[0099] By the above, multiplex record of the recording information over two or more include-angle recording surfaces which can be set in two or more record area is completed.

[0100] As explained above, according to this operation gestalt, a control unit 18 sets up the record include angle at the time of recording the first include-angle recording surface in the hologram record medium 200 as a criteria record include angle. And under control by the control unit 18, predetermined changes the record include angle after recording the first include-angle recording surface a minute include angle every on the basis of this set-up criteria record include angle, and record include-angle modification equipment 19 is fixed. Therefore, it becomes possible to make in agreement the record include angle which must be equivalent to the criteria record include angle specified by the mechanical condition or setups by the side of the hologram recording device 100 like the case of the 1st operation gestalt, and the criteria record include angle by the side of the hologram record medium 200 at the time of the first record.

[0101] (Deformation gestalt of a hologram recording device) The reference beam phase multiplex system which changes the phase of a reference beam L2 and performs multiplex record may be combined with the include-angle multiplex system in this operation gestalt mentioned above to each still more nearly above-mentioned operation gestalt. What is necessary is to arrange the optical element for phase polarization to the optical path of a reference beam L2 in this case, to change the phase of a reference beam L2, and just to perform the same hologram record as the above according to this phase in piles to the same record section.

[0102] Furthermore, it may replace with such reference beam phase multiplex system, or, in addition, the reference beam amplitude multiplex system which changes the amplitude of a reference beam L2 and performs multiplex record may be combined. What is necessary is to arrange the optical element for amplitude modification to the optical path of a reference beam L2 in this case, to change the amplitude of a

reference beam L2, and just to perform the same hologram record as the above according to this amplitude in piles to the same record section.
[0103] Furthermore, it may replace with such reference beam phase multiplex system or reference beam amplitude multiplex system, or, in addition, the reference beam polarization multiplex system which changes the polarization condition of a reference beam L2, and performs multiplex record may be combined with the include-angle multiplex system in this operation gestalt mentioned above. What is necessary is to arrange the optical element for polarization status changes to the optical path of a reference beam L2 in this case, to change the changeover state of a reference beam L2, and just to perform the same hologram record as the above according to this changeover state in piles to the same record section.
[0104] Furthermore, it may replace with such reference beam phase multiplex system, reference beam amplitude multiplex system, or reference beam polarization multiplex system, or, in addition, the depth of focus multiplex system which changes the depth of focus of the signal light L3, and performs multiplex record may be combined with the include-angle multiplex system in this operation gestalt mentioned above. in this case, the thing of laser equipment 11 or lenses 13 and 14, and 16 grades for which the location of an optical element is changed -- or what is necessary is to add the optical element for focal distance modification, or to add the machine element which changes the location by the side of the hologram record medium 200, to change the depth of focus, and just to perform the same hologram record as the above according to the depth of focus in piles to the same record section
[0105] According to these deformation gestalten, compared with the operation gestalt mentioned above, hologram record of high density is attained more.
[0106] (Operation gestalt of a hologram regenerative apparatus) The operation gestalt of the hologram regenerative apparatus of this invention is explained with reference to drawing 5 and drawing 6 .
[0107] First, with reference to drawing 5 , the whole hologram regenerative-apparatus configuration concerning this operation gestalt is explained. It is the block diagram showing the whole hologram regenerative-apparatus configuration which drawing 5 requires for this operation gestalt here.
[0108] The hologram regenerative apparatus 300 concerning this operation gestalt reads recording information from the hologram record medium 200 recorded by the hologram recording device 100 of the operation gestalt mentioned above.
[0109] As shown in drawing 5 , the hologram regenerative apparatus 300 Example slack laser equipment 21 of the light sources, such as semiconductor laser, which irradiates the playback illumination light L10 at the hologram record medium 200, The mirrors 22 and 23 which lead the playback illumination light L10 to the hologram record medium 200, The lens 24 which condenses the playback light L11 based on the playback illumination light from the hologram record medium 200, It has the light-receiving equipment 25 which receives the playback light L11 through this lens 24, and the reader 26 which reads the recording information recorded on the hologram record medium 200 based on the light-receiving signal Sr outputted from light-receiving equipment 25 corresponding to the this received playback light L11.
[0110] The hologram regenerative apparatus 300 is equipped with the playback include-angle modification equipment 29 which can change the include angle of the playback illumination light L10 to the front face of the hologram record medium 200 small [every], and can fix it, and the control unit 28 which controls playback include-angle modification equipment 29 so that the playback illumination light L10 serves as a playback include angle corresponding to the include-angle recording surface in the hologram record medium 200 which should be reproduced. In addition, this operation gestalt defines the include angle which the optical axis of the playback illumination light L10 makes to the front face of the hologram record medium 200 as a "playback include angle."
[0111] Playback include-angle modification equipment 29 may be constituted so that the laser equipment 21 which makes optical system, and the include angle and arrangement to each optical axis of mirrors 22 and 23 may be changed that what is necessary is just to change relatively the playback include angle of the playback illumination light L10 to the front face of the hologram record medium 200, and it may carry out additional arrangement of the optical element of dedication which changes the include angle of the playback lighting L10 to this optical system. Or it may be constituted so that the maintenance include angle of the hologram record medium 200 may be mechanically replaced with or changed into this in addition. About the include-angle modification actuation by the playback include-angle modification equipment 29 to apply, it is controlled to make a part of a series of playback actuation mentioned later with a control unit 28.
[0112] A control unit 28 carries out the generation output of control signal S1' according to the recording information which should be reproduced from the hologram record medium 200 coming [the controller which consists of a microprocessor], and like ****, it is constituted so that the playback include angle in

playback include-angle modification equipment 29 may be controlled.
[0113] Thus, the light-receiving equipment 25 which receives the playback light L11 generated through a lens 24 comes to contain for example, a photodiode array, CCD (Charge Coupled Device), etc.
[0114] The reader 26 is preferably stored in memory by using as a table relation between the light-and-darkness pattern with which light-receiving equipment 25 is received, and the value of two or more recording information modulated per cel by the space optical modulator 15 (refer to drawing 1) when the hologram record medium 200 was recorded. And each recording information is read by specifying the light-and-darkness pattern of the received playback light L11, and specifying the recording information corresponding to the light-and-darkness pattern specified with reference to this table. Therefore, two or more recording information recorded on the include-angle recording surface of 1 in the record area of 1 can be read simultaneously.
[0115] With especially this operation gestalt, reading of the criteria include-angle recording surface in which the include-angle reference signal Sa was written among two or more include-angle recording surfaces which can be set to the hologram record medium 200 to the include-angle reference signal Sa concerned is possible for a reader 26. And if the include-angle reference signal Sa is read in this way, the reader 26 is constituted so that this may be outputted to a control unit 28.
[0116] A control unit 28 can identify easily the difference of the hologram record medium 200, or the difference of the hologram regenerative apparatus 300 for whether which include-angle recording surface is a criteria include-angle recording surface based on the include-angle reference signal Sa, without asking.
[0117] Furthermore, a control unit 28 proofreads playback include-angle modification equipment 29 based on the criteria record include angle shown by the include-angle reference signal Sa. That is, according to the criteria playback include angle corresponding to the criteria include-angle recording surface first shown by the include-angle reference signal Sa, in case the include-angle recording surface of arbitration is reproduced, it is constituted so that a calibration may be applied to playback include-angle modification equipment 29. The angular difference of the playback include angle in setups, such as a mechanical condition that it should correspond to the criteria playback include angle in the playback include-angle modification equipment 29 in the event of more specifically, for example, this time, reproducing, or optical system, and the criteria playback include angle corresponding to the criteria include-angle recording surface shown by the include-angle reference signal Sa is detected. Furthermore, only this detected angular difference imposes offset, and playback include-angle modification equipment 29 is constituted so that a playback include angle may be changed.
[0118] In addition, the hologram regenerative apparatus 300 is further equipped with the migration equipment 30 made to move the location where the playback lighting L10 is condensed to the front face of the hologram record medium 200 in the direction which met the front face relatively.
[0119] Migration equipment 30 moves the condensing location of the playback illumination light L10 by changing the include angle of the optical system of a mirror 22 and 23 grades, and arrangement. Or you may move by changing the include angle of other optical elements of laser equipment 21 grade, and arrangement, and additional arrangement of the optical elements (for example, mirror whose installation include angle is adjustable) of the dedication for such migration may be carried out at the optical path of the playback illumination light L10. Furthermore, you may also include the device to which hologram record-medium 200 the very thing is mechanically moved along the front face according to the maintenance device of the hologram record medium 200. Also about the migration actuation by the migration equipment 30 to apply, it is controlled by control signal S2' by which a generation output is carried out with a control unit 28 to make a part of a series of playback actuation mentioned later.
[0120] Next, with reference to drawing 6 , fundamental playback actuation of the hologram regenerative apparatus 300 of this constituted operation gestalt is explained like the above.
[0121] At the time of the actuation, laser equipment 21 irradiates the playback illumination light L10 through mirrors 22 and 23 at a hologram 200. Then, light-receiving equipment 25 receives the playback light L11 based on the playback illumination light L10 in the hologram record medium 200. They are high order light, such as zero-order light which produces the playback light L11 here when the playback illumination light L10 corresponding to the reference beam at the time of record is irradiated by the hologram record medium 200, or primary light, etc. With the property of hologram record, such a playback light L11 does so the same light-and-darkness pattern as the modulated signal light L3 which was shown in drawing 1 .
[0122] Then, based on the playback light L11 received by this light-receiving equipment 25, playback of each recording information recorded on the hologram record medium 200 with which high density record of

the reader 26 was carried out like **** is performed.
[0123] Playback of the recording information over one include-angle recording surface corresponding to one playback include angle in one record area where the playback illumination light L10 is irradiated at a stretch is performed by the above fundamental playback actuation.
[0124] Next, the detail of playback actuation of the include-angle multiplex mold in the hologram regenerative apparatus 300 of this operation gestalt which performs such playback to two or more include-angle recording surfaces, and performs it to further two or more record area is explained with reference to drawing 6 . It is the flow chart which shows the record actuation which drawing 6 requires here.
[0125] In drawing 6 , the playback light L11 based on the playback illumination light L10 is first received with light-receiving equipment 25. According to this, the include-angle reference signal Sa outputted from a reader 26 is checked by the control device 28 (step S41). And based on the angular difference of the playback include angle at present currently fixed by playback include-angle modification equipment 29, and the criteria playback include angle corresponding to the criteria include-angle recording surface shown by the include-angle reference signal Sa, the calibration to playback include-angle modification equipment 29 is performed (step S42). This calibration is performed by applying the offset according to above-mentioned angular difference to control signal S1' inputted into playback include-angle modification equipment 29.
[0126] Then, it is judged by the control unit 28 to the include-angle recording surface at present in the record area in this time of the hologram record medium 200 fixed by migration equipment 30 fixed by playback include-angle modification equipment 29 whether data playback of recording information is performed (step S43).
[0127] the case where data playback is not performed here -- (step S43:No) -- processing is ended as it is. That is, it means that it performed effectively about the check (step S41) of the include-angle reference signal Sa in this case.
[0128] On the other hand, as a result of the judgment of step S43, when performing data playback, (step S43:Yes) and the playback illumination light L10 are irradiated, and actual data playback is performed by light-receiving equipment 25 and reader 26 grade (step S44).
[0129] Then, it is judged by the control unit 28 to the following include-angle recording surface which can be changed with the playback include-angle modification equipment 29 in the record area in this time of the hologram record medium 200 fixed by migration equipment 30 whether data playback of recording information is performed (step S45).
[0130] Here, when performing data playback to the following include-angle recording surface, in response to control by (step S45:Yes) control signal S1', only a minute include angle (for example, 0.01 degrees) predetermined in a playback include angle is changed by playback include-angle modification equipment 29 (step S46). Under the present circumstances, since the calibration on the basis of a criteria playback include angle is performed in playback include-angle modification equipment 29 like the above-mentioned, it is possible to change such a playback include angle into accuracy. And it returns to step S43 and subsequent processings are repeated.
[0131] On the other hand, as a result of the judgment of step S45, when not performing data playback to the following include-angle recording surface, it is judged by the control unit 28 whether (step S45:No) and migration equipment 30 perform data playback of recording information to other movable record area (step S47).
[0132] Here, when performing data playback to other record area, the playback include angle which changes with playback include-angle modification equipment 29, and is fixed in response to control by (step S47:Yes) control signal S1' is reset. That is, a playback include angle is changed by playback include-angle modification equipment 29, and it is fixed so that it may become a playback include angle corresponding to the first include-angle recording surface in the next record area (step S48). Under the present circumstances, since the calibration on the basis of a criteria playback include angle is performed in playback include-angle modification equipment 29 like the above-mentioned, it is possible to reset such a playback include angle to accuracy, and it is also possible to also make a change of the playback include angle after reset to accuracy further.
[0133] Then, in response to control by control signal S2', only predetermined distance is moved by migration equipment 30 and let with it the fields where the playback illumination light L10 is irradiated be other record area (step S49). And it returns to step S16 and subsequent processings are repeated.
[0134] On the other hand, as a result of the judgment of step S47, in not performing data playback to other record area, it ends (step S47:No) and a series of regeneration.
[0135] By the above, playback of the recording information over two or more include-angle recording

surfaces which can be set in two or more record area is completed.
[0136] As explained above, under control by the control unit 28, on the basis of the criteria playback include angle corresponding to the criteria include-angle recording surface shown by the include-angle reference signal Sa, predetermined changes playback include-angle modification equipment 29 a minute include angle every, and, according to this operation gestalt, it is fixed. Therefore, it becomes possible to make in agreement the playback include angle which must be equivalent to the criteria playback include angle specified by a mechanical condition or setups, such as optical system which becomes the hologram regenerative-apparatus 300 side 29, i.e., playback include-angle modification equipment, and a list from laser equipment 21 and mirrors 22 and 23, and the criteria playback include angle by the side of the hologram record medium 200 at the time of the first playback. That is, it is the same model about both [these] include angles, and also when using any of another hologram regenerative apparatus 300, it becomes possible to make it in agreement [without being based on the variation between equipment]. And after it, playback from an include-angle recording surface can be performed to quick and accuracy also about which playback include angle on the basis of a criteria playback include angle.
[0137] This invention is not restricted to the operation gestalt mentioned above, and can be suitably changed in the range which is not contrary to the summary or thought of invention which can be read in a claim and the whole description, and a hologram regenerative apparatus and an approach are also included in the hologram recording device and approach list accompanied by such modification in the technical range of this invention.
[0138]
[Effect of the Invention] As explained to the detail above, it is possible in the hologram recording device and approach list of this invention to raise recording density and storage capacity according to a hologram regenerative apparatus and the approach, and, moreover, it is possible accuracy and to perform record actuation and playback actuation promptly.

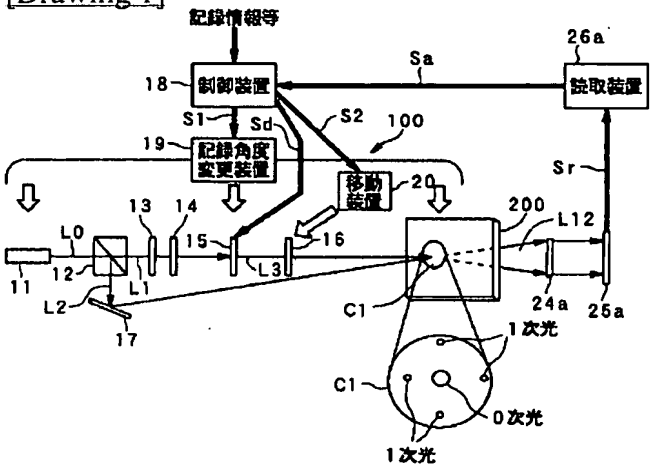
[Translation done.]

* NOTICES *

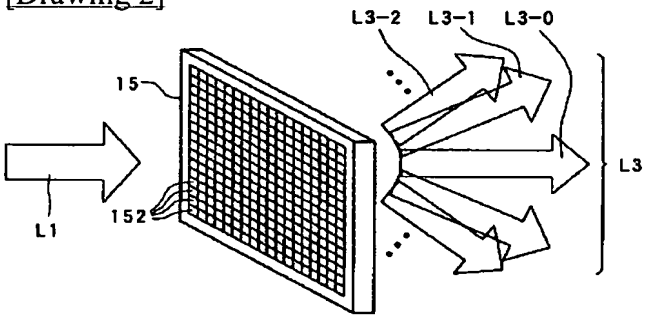
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

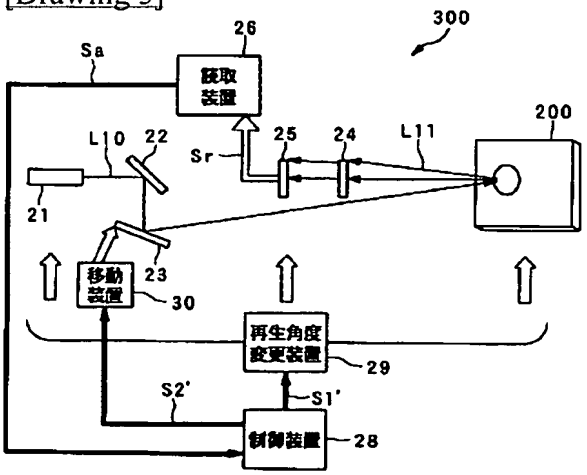
[Drawing 1]



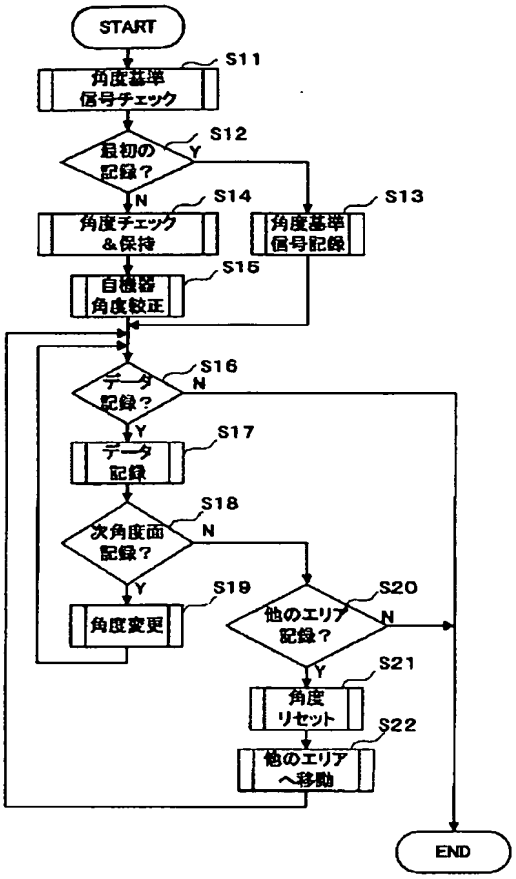
[Drawing 2]



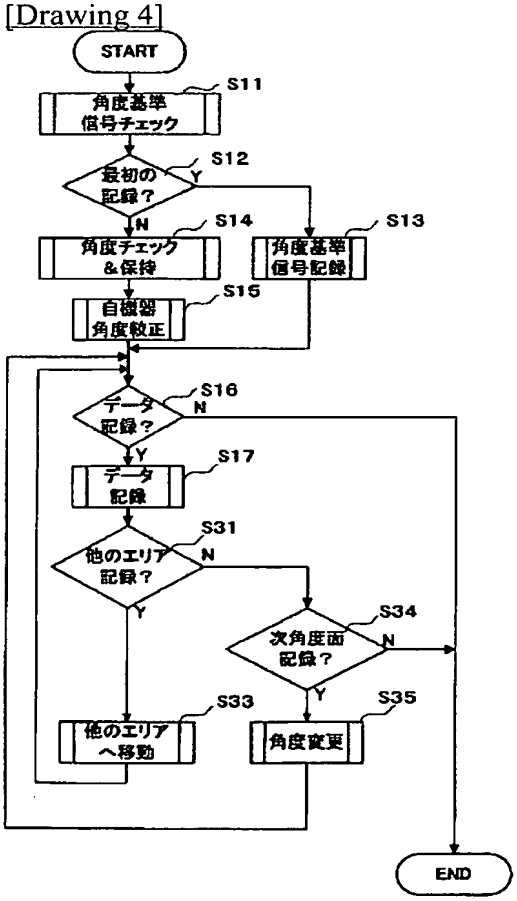
[Drawing 5]



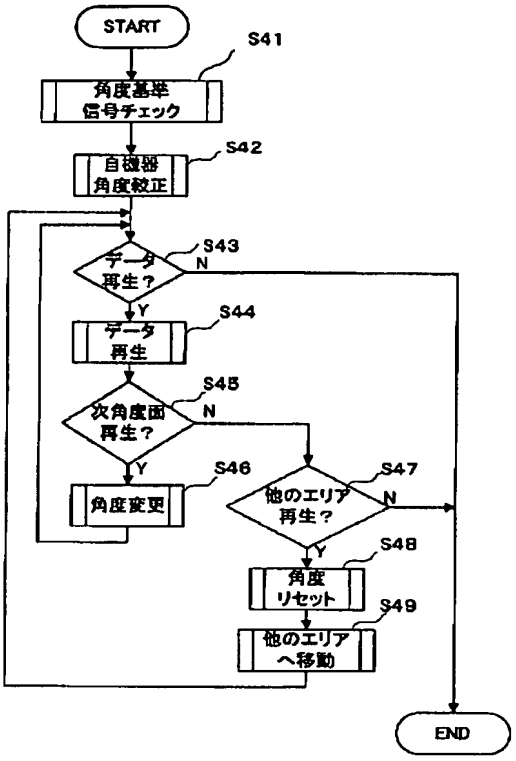
[Drawing 3]



[Drawing 4]



[Drawing 6]



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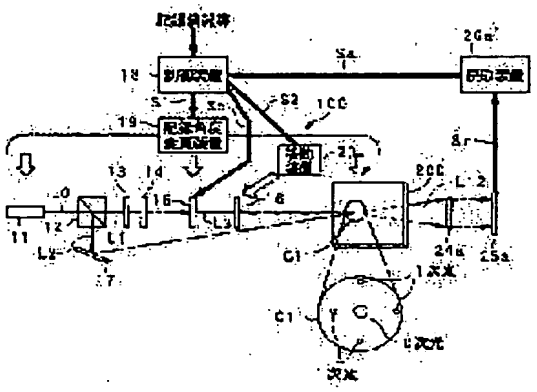
(54) HOLOGRAM RECORDING DEVICE AND METHOD OF ANGLE MULTIPLE TYPE AND HOLOGRAM RECONSTRUCTING DEVICE AND METHOD

(57)Abstract:
PROBLEM TO BE SOLVED: To improve the recording density and recording capacity in hologram recording and reconstructing and to exactly and rapidly perform a recording operation and reconstructing operation.
SOLUTION: The hologram recording device (100) is provided with recording angle changing means (19) capable of relatively changing the recording angle of a hologram recording medium (200) with respect to signal light (L3) and reference light (L2) and control means (18). The control means sets the recording angle in recording a specific angle recording surface among a plurality of angle recording surfaces of the hologram recording medium as a reference recording angle. Further, the recording angle changing means is so controlled that the subsequent recording angle is changed and fixed by the prescribed angle each on the basis of the set reference recording angle.



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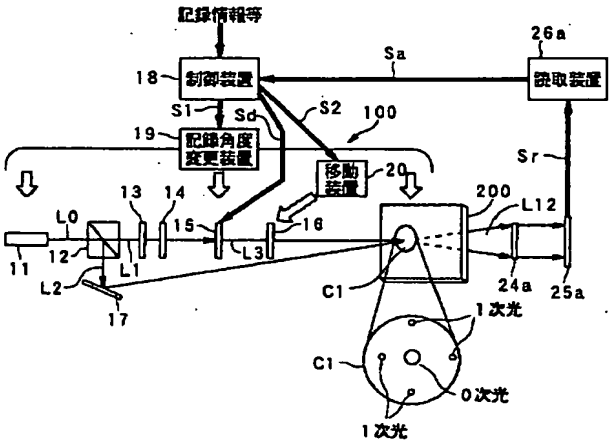
最終頁に続く

(54)【発明の名称】角度多重型のホログラム記録装置及び方法並びにホログラム再生装置及び方法

(57)【要約】

【課題】　ホログラム記録及び再生において、記録密度及び記録容量を向上させ、しかも正確且つ迅速に記録動作や再生動作を行う。

【解決手段】　ホログラム記録装置（１００）は、信号光（Ｌ３）及び参照光（Ｌ２）に対するホログラム記録媒体（２００）の記録角度を相対的に変更可能な記録角度変更手段（１９）と、制御手段（１８）とを備える。制御手段は、ホログラム記録媒体における複数の角度記録面のうち特定の角度記録面を記録する際の記録角度を基準記録角度として設定する。更に、以降における記録角度を、この設定された基準記録角度を基準として所定角度ずつ変更し固定するように記録角度変更手段を制御する。



【特許請求の範囲】

【請求項１】　光源光を照射する光源と、
該照射される光源光を信号光及び参照光に分離する第１光学系と、
前記信号光の光路に配置されており前記信号光を変調可能な空間光変調器と、
該空間光変調器を通過した信号光と前記参照光とをホログラム記録媒体上に導く第２光学系と、
前記信号光及び前記参照光に対する前記ホログラム記録媒体の記録角度を相対的に変更可能な記録角度変更手段と、
前記ホログラム記録媒体における複数の角度記録面のうち特定の角度記録面を記録する際の前記記録角度を基準記録角度として設定し、以降における前記記録角度を前記設定された基準記録角度を基準として所定角度ずつ変更し固定するように前記記録角度変更手段を制御する制御手段とを備えたことを特徴とする角度多重型のホログラム記録装置。

【請求項２】　前記空間光変調器は、前記ホログラム記録媒体が未記録の場合、前記特定の角度記録面に対して、前記基準記録角度に対応する基準角度記録面である旨を示す角度基準識別情報を記録することを特徴とする請求項１に記載の角度多重型のホログラム記録装置。

【請求項３】　前記制御手段は、少なくとも前記特定の角度記録面に対して記録情報が記録された後における前記ホログラム記録媒体に対しては、前記角度基準識別情報に基づいて前記記録角度変更手段を較正することを特徴とする請求項２に記載のホログラム記録装置。

【請求項４】　前記ホログラム記録媒体における複数の角度記録面のうち一つには、前記基準記録角度に対応する基準角度記録面である旨を示す角度基準識別情報が記録されており、
前記制御手段は、前記角度基準識別情報に基づいて前記記録角度変更手段を較正することを特徴とする請求項１に記載のホログラム記録装置。

【請求項５】　前記第２光学系により導かれる前記信号光及び前記参照光の集光位置に対して、前記ホログラム記録媒体を相対的に移動させる移動手段を更に備えたことを特徴とする請求項１から４のいずれか一項に記載の角度多重型のホログラム記録装置。

【請求項６】　前記空間光変調器は、前記移動手段による移動毎に、前記ホログラム記録媒体の全ての角度記録面に対する記録を行うことを特徴とする請求項５に記載の角度多重型のホログラム記録装置。

【請求項７】　前記特定の角度記録面は、前記複数の角度記録面のうち最初に記録される角度記録面であることを特徴とする請求項１から６のいずれか一項に記載の角度多重型のホログラム記録装置。

【請求項８】　複数の角度記録面のうち一つに基準角度記録面である旨を示す角度基準識別情報が記録されている角度多重型のホログラム記録媒体から記録情報を再生するホログラム再生装置であって、

再生照明光を前記ホログラム記録媒体に照射する光源と、
前記ホログラム記録媒体からの、前記再生照明光に基づく再生光を受光する受光手段と、
該受光された再生光に基づいて、前記ホログラム記録媒体に重ねて記録された前記複数の記録情報を夫々読み取る読取手段と、
前記再生照明光に対する前記ホログラム記録媒体の再生角度を相対的に変更可能な再生角度変更手段と、
前記再生角度を前記基準角度記録面に対応する基準再生角度を基準として所定角度ずつ変更させ且つ固定するように前記再生角度変更手段を制御する制御手段とを備えており、
前記制御手段は、前記角度基準識別情報に基づいて前記再生角度変更手段を較正することを特徴とするホログラム再生装置。

【請求項９】　前記再生照明光の集光位置に対して、前記ホログラム記録媒体を相対的に移動させる移動手段を更に備えたことを特徴とする請求項８に記載の角度多重型のホログラム再生装置。

【請求項１０】　前記読取手段は、前記移動手段による移動毎に、前記ホログラム記録媒体の全ての角度記録面に対する再生を行うことを特徴とする請求項９に記載の角度多重型のホログラム再生装置。

【請求項１１】　光源光を照射する光源と、該照射される光源光を信号光及び参照光に分離する第１光学系と、前記信号光の光路に配置されており前記信号光を変調可能な空間光変調器と、該空間光変調器を通過した信号光と前記参照光とをホログラム記録媒体上に導く第２光学系と、前記信号光及び前記参照光に対する前記ホログラム記録媒体の記録角度を相対的に変更可能な記録角度変更手段とを備えた角度多重型のホログラム記録装置によるホログラム記録方法であって、
前記ホログラム記録媒体における複数の角度記録面のうち特定の角度記録面を記録する際の前記記録角度を基準記録角度として設定する工程と、
以降における前記記録角度を前記設定された基準記録角度を基準として所定角度ずつ変更し固定するように前記記録角度変更手段を制御する工程とを備えたことを特徴とする角度多重型のホログラム記録方法。

【請求項１２】　前記特定の角度記録面は、前記複数の角度記録面のうち最初に記録される角度記録面であることを特徴とする請求項１１に記載の角度多重型のホログラム記録方法。

【請求項１３】　複数の角度記録面のうち一つに基準角度記録面である旨を示す角度基準識別情報が記録されている角度多重型のホログラム記録媒体から記録情報を再生するホログラム再生装置であって、再生照明光を前記

ホログラム記録媒体に照射する光源と、前記ホログラム記録媒体からの、前記再生照明光に基づく再生光を受光する受光手段と、該受光された再生光に基づいて、前記ホログラム記録媒体に重ねて記録された前記複数の記録情報を夫々読み取る読取手段と、前記再生照明光に対する前記ホログラム記録媒体の再生角度を相対的に変更可能な再生角度変更手段とを備えた角度多重型のホログラム再生装置によるホログラム再生方法において、

前記角度基準識別情報に基づいて前記再生角度変更手段を較正する工程と、

前記再生角度を前記基準角度記録面に対応する基準再生角度を基準として所定角度ずつ変更させ且つ固定するように前記再生角度変更手段を制御する工程とを含むことを特徴とする角度多重型のホログラム再生方法。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、空間光変調器（Spatial Light Modulator）を介して信号光をホログラム記録媒体に照射し、情報を記録するホログラム記録装置及び方法並びに該ホログラム記録媒体から情報を再生するホログラム再生装置及び方法の技術分野に属する。特に、参照光及び信号光のホログラム記録媒体の表面に対する角度を相対的に変えることで同一エリアに異なる記録情報を多重記録し、これを再生する角度多重型のホログラム記録装置及び方法並びにホログラム再生装置及び方法の技術分野に属する。

【０００２】

【従来の技術】従来、ホログラム記録装置では、例えば液晶装置等から構成され、記録すべき記録情報に応じて変調を行う空間光変調器に、信号光たるレーザ光が照射される。ここで特に、空間光変調器は、マトリクス状にセルが平面配列されており、セル毎に光透過率を記録情報に応じて変えることで、信号光を変調する。更に、変調された信号光を、微細ピッチを持つセルにおける回折現象によって０次光、１次光等の複数の回折光として、異なる出射角度で出射する。この際、出射角度は、変調単位であるセルのピッチにより規定される。そして、このように構成された空間光変調器により変調された信号光と空間光変調器を経ない参照光とが、ホログラム記録媒体上で干渉させられる。これにより、ホログラム記録媒体に記録情報が波面として記録されるように構成されている。

【０００３】特に記録時に、参照光及び信号光に対するホログラム記録媒体の表面の角度を僅かずつ変更することによって、同一エリアに異なる記録情報を多重記録する角度多重型のホログラム記録装置も提案されている。本願では、このような角度多重型の記録における、ホログラム記録媒体の表面に対する信号光の角度を適宜“記録角度”と呼ぶ。更に、例えばホログラム記録媒体の表面の法線に一致する際の記録角度など、記録角度の基準となる角度を適宜“基準記録角度”と呼ぶ。更にまた、本願では、各記録角度に対応する記録面を“角度記録面”と呼び、基準記録角度に対応する記録面を“基準角度記録面”と呼ぶことにする。

【０００４】他方、このようなホログラム記録装置と対をなすホログラム再生装置は、再生照明光に対するホログラム記録媒体の表面の角度を僅かずつ変更することによって、同一エリアに多重記録された記録情報を再生するように構成されている。本願では、このような角度多重型の再生における、ホログラム記録媒体の表面に対する再生照明光の角度を適宜“再生角度”と呼ぶ。更に、例えばホログラム記録媒体の表面の法線に一致する際の再生角度など、再生角度の基準となる角度を適宜“基準再生角度”と呼ぶ。

【０００５】角度多重型のホログラム記録装置によれば、記録角度を基準記録角度から例えば０．０１度刻みで最大数度の範囲で変更して（例えば８８度～９２度の間で僅かずつ変更して）、同一記録エリアにおける各角度記録面に対する記録を、記録角度毎に順次行う。尚、本願では、信号光及び参照光が一時に照射されるホログラム記録媒体の表面上の領域を“記録エリア”と呼ぶことにする。角度多重型の場合、同一記録エリアに、例えば５０面といった複数の角度記録面が記録されることになる。

【０００６】他方、角度多重型のホログラム再生装置によれば、再生角度を基準再生角度から、記録角度の場合に対応して僅かに変更することによって、同一エリアに多重記録された記録情報を、再生角度別に再生する。

【０００７】このように角度多重型のホログラム記録装置及びホログラム再生装置によれば、同一エリアに記録角度別に記録される多数の角度記録面に記録情報を夫々記録でき且つこれを夫々再生できるので、記録密度及び記録容量を飛躍的に増大できるものとされている。

【０００８】

【発明が解決しようとする課題】しかしながら、ホログラム記録においては一般に、角度選択性が非常に大きい。このため、同一機種であり且つ別のホログラム記録装置、ホログラム記録再生装置又はホログラム再生装置を用いて、同一のホログラム記録媒体（例えば、リムーバブルな記録媒体）に対する記録（追記）や再生を行う場合、装置間のバラツキによって、各装置における当該ホログラム記録媒体を前述の基準記録角度或いは基準再生角度で固定する際の機構及び光学系等の機械的状態或いは設定条件が、各装置間で一致するとは限らない。例えば、装置間のバラツキによっては、一の装置で基準記録角度に対応するものとして記録された基準角度記録面は、他の装置における基準記録角度或いは基準再生角度に対応する筈の機構及び光学系等の機械的状態或いは設定条件に、実際には対応しなくなる。即ち、このような機械的状態或いは設定条件の下では、基準角度記録面と

は異なる角度記録面が基準角度記録面であると誤認されてしまう可能性がある。或いは、基準角度の誤認により、記録（追記）しようとする角度記録面とは異なる角度記録面に記録したり、再生しようとする角度記録面とは異なる角度記録面を再生したり、記録角度と再生角度との対応が取れないために再生不能に陥ったりする可能性があるという技術的問題点が生じる。

【０００９】本発明は上述した問題点に鑑みなされたものであり、記録密度及び記録容量を向上させることが可能であり、しかも正確且つ迅速に記録動作や再生動作を行うことが可能である角度多重型のホログラム記録装置及び方法並びにホログラム再生装置及び方法を提供することを課題とする。

【００１０】

【課題を解決するための手段】本発明の角度多重型のホログラム記録装置は上記課題を解決するために、光源光を照射する光源と、該照射される光源光を信号光及び参照光に分離する第１光学系と、前記信号光の光路に配置されており前記信号光を変調可能な空間光変調器と、該空間光変調器を通過した信号光と前記参照光とをホログラム記録媒体上に導く第２光学系と、前記信号光及び前記参照光に対する前記ホログラム記録媒体の記録角度を相対的に変更可能な記録角度変更手段と、前記ホログラム記録媒体における複数の角度記録面のうち特定の角度記録面を記録する際の前記記録角度を基準記録角度として設定し、以降における前記記録角度を前記設定された基準記録角度を基準として所定角度ずつ変更し固定するように前記記録角度変更手段を制御する制御手段とを備える。

【００１１】本発明のホログラム記録装置によれば、その動作時には、半導体レーザ装置等の光源は、レーザ光等の光源光を照射する。第１光学系は、この光源光を、信号光及び参照光に分離する。ここで、信号光の光路に配置された、例えば液晶装置等から構成される空間光変調器は、信号光に対する変調を行う。その後、第２光学系は、この変調された信号光と、第１光学系で分離された参照光とをホログラム記録媒体上に導く。この結果、ホログラム記録媒体上では、これら信号光と参照光との干渉により、記録情報が波面として記録される。

【００１２】この際特に、制御手段は、ホログラム記録媒体における、例えば最初の角度記録面等の特定の角度記録面を記録する際の記録角度を基準記録角度として設定する。そして、記録角度変更手段は、制御手段による制御下で、特定の角度記録面を記録した以降における記録角度を、この設定された基準記録角度を基準として、所定角度ずつ変更し固定する。よって、当該ホログラム記録装置側における記録角度変更手段及び光学系等の機械的状態或いは設定条件により規定される基準記録角度と、ホログラム記録媒体側における基準記録角度とを、例えば最初の記録時等の特定の記録時に一致させることが可能となる。即ち、これらを、同一機種であり且つ別のホログラム記録装置のいずれを使用する場合にも、装置間のバラツキによらずに各ホログラム記録装置について特定の記録時に一致させることが可能となる。しかもそれ以降は、各ホログラム記録装置について特定の記録時に設定された基準記録角度を基準として、いずれの記録角度についても正確に角度記録面への記録を行える。

【００１３】ここで比較のため、予め角度記録面別にその記録角度を示す角度情報をホログラム記録媒体に記録しておき、各角度記録面に対する記録（追記）や再生を行う際に、該角度情報を先ず参照することで、角度変更の都度にいずれの角度記録面に対する記録（追記）や再生を行うかを確認してから実際の記録（追記）や再生を行う場合を想定する。この場合には、記録角度を変更する都度に、いずれの角度記録面であるかを確認する作業が発生するので、迅速なる記録動作は困難となる。更にこのような角度情報等を記録する分だけ、それ以外のコンテンツ情報等の実際に記録したい記録情報用の記録容量が減ってしまう。

【００１４】これに対して、本発明のホログラム記録装置は、特定の記録時に設定された基準記録角度を基準として、その後の迅速なる角度変更と記録動作が可能となるのである。

【００１５】このように本発明によれば、角度多重により記録密度及び記録容量を飛躍的に高めることができ、しかも装置間のバラツキによらずに正確に角度多重型の多重記録を行うことができ、迅速なる記録動作も可能となる。

【００１６】尚、本発明では、空間光変調器は、記録情報の示す２値データに応じて２値変調してもよい。これにより、２値データを示す記録情報を、高密度でホログラム記録媒体に記録できる。或いは、記録情報の示す階調データに応じて多値変調してもよい。これにより、階調データを示す記録情報を、高密度でホログラム記録媒体に記録できる。

【００１７】更に、本発明では、空間光変調器から出射される変調後の信号光は、回折による０次光及びＬ次光（但し、Ｌは、１以上の自然数）のうち少なくとも一つからなる。例えば、回折光のうち０次光のみを利用して或いは０次光と一又は複数の１次光等の高次光とを利用して、高密度でホログラム記録が可能となる。

【００１８】加えて、上述した本発明の角度多重型のホログラム記録装置に対して、参照光の位相を変えて多重記録を行う参照光位相多重方式、参照光の振幅を変えて多重記録を行う参照光振幅多重方式、参照光の偏光を変えて多重記録を行う参照光偏光多重方式、及びホログラム記録媒体に入射する信号光の焦点深度を変えて多重記録を行う焦点深度多重方式のうち少なくとも一つの方式を組み合わせてもよい。これにより、一層高密度のホログラム記録が可能となる。

【００１９】本発明の角度多重型のホログラム記録装置の一態様では、前記空間光変調器は、前記ホログラム記録媒体が未記録の場合、前記特定の角度記録面に対して、前記基準記録角度に対応する基準角度記録面である旨を示す角度基準識別情報を記録する。

【００２０】この態様によれば、ホログラム記録媒体が未記録の場合、空間光変調器は、特定の角度記録面に対して、角度基準識別情報を記録する。従って、その後は、この角度基準識別情報に基づいて、当該ホログラム記録媒体に対して既に基準記録角度が設定されていることが容易に認識でき、且つ、いずれの角度記録面が、基準角度記録面であるかをホログラム記録装置の異同を問わずに容易に識別可能となる。

【００２１】本発明の角度多重型のホログラム記録装置の他の態様では、前記制御手段は、少なくとも前記特定の角度記録面に対して記録情報が記録された後における前記ホログラム記録媒体に対しては、前記角度基準識別情報に基づいて前記記録角度変更手段を較正する。

【００２２】この態様によれば、特定の角度記録面に対して記録した後、他の角度記録面に対して記録情報を記録する際には、制御手段は、先ず角度基準識別情報に基づいて記録角度変更手段を較正する。より具体的には例えば、今回記録する時点での記録角度変更手段における基準記録角度に対応する筈の機械的状態或いは光学系等の設定条件に対応する角度記録面と、角度基準識別情報により示される基準角度記録面との角度差を検出し、該検出された角度差だけオフセットを掛けて、記録角度変更手段は、記録角度を変更する。これにより、機械的状態或いは光学系等の設定条件の経時的変化、ホログラム記録媒体のローディング或いはセッティング角度の変化などが、ホログラム記録媒体の角度選択性に比べて無視し得ない程度に大きくても、オフセットによりこのような変化が補償されて、いずれの角度記録面に対しても正確に記録情報の記録（追記）を行える。

【００２３】或いは本発明の角度多重型のホログラム記録装置の他の態様では、前記ホログラム記録媒体における複数の角度記録面のうち一つには、前記基準記録角度に対応する基準角度記録面である旨を示す角度基準識別情報が記録されており、前記制御手段は、前記角度基準識別情報に基づいて前記記録角度変更手段を較正する。

【００２４】この態様によれば、既に記録が行われて角度基準識別情報が記録された角度記録面を有するホログラム記録媒体に対して記録を行う際には、制御手段は、角度基準識別情報に基づいて記録角度変更手段を較正する。より具体的には例えば、今回記録する時点での記録角度変更手段における基準記録角度に対応する筈の機械的状態或いは光学系等の設定条件に対応する角度記録面と、角度基準識別情報により示される基準角度記録面との角度差を検出し、以降は、該検出された角度差だけオフセットを掛けて、記録角度変更手段は、記録角度を変更し固定する。これにより、最初に基準角度面に記録を行った他のホログラム記録装置及び今回記録を行おうとするホログラム記録装置間で、記録角度変更手段における機械的状態或いは光学系等の設定条件が一致していなくても、オフセットによりこのような差異が補償されて、今回記録を行おうとするホログラム記録装置により正確に記録情報の記録（追記）を行える。

【００２５】本発明の角度多重型のホログラム記録装置の他の態様では、前記第２光学系により導かれる前記信号光及び前記参照光の集光位置に対して、前記ホログラム記録媒体を相対的に移動させる移動手段を更に備える。

【００２６】この態様によれば、信号光と参照光とが集光される一つの記録エリアに対する角度多重による一又は複数の角度記録面に対する記録が完了した際には、移動手段は、ホログラム記録媒体を相対的に移動させる。これにより、他の記録エリアに信号光及び参照光が集光され、当該他の記録エリアに対して同様に複数の角度記録面に対する記録が行われる。

【００２７】この態様では、前記空間光変調器は、前記移動手段による移動毎に、前記ホログラム記録媒体の全ての角度記録面に対する記録を行うように構成してもよい。

【００２８】このように構成すれば、移動手段による移動の回数や移動量を小さく抑えることが可能となる。更に、移動手段による移動に伴って発生し得る、記録角度変更手段及び光学系等の機械的状態或いは設定条件における変化を最小限に抑えることも可能となる。

【００２９】尚、一の記録エリアにおける全ての角度記録面に対する記録を完了する前に、移動手段による移動を行ってもよい。或いは、一の記録エリアにおける一の角度記録面に対する記録を完了する毎に、移動手段による移動を行うことも可能である。

【００３０】本発明の角度多重型のホログラム記録装置の他の態様では、前記特定の角度記録面は、前記複数の角度記録面のうち最初に記録される角度記録面である。

【００３１】この態様によれば、ホログラム記録媒体における最初の角度記録面を記録する際の記録角度を基準記録角度として設定する。よって、最初の記録時に設定された基準記録角度を基準として、いずれの記録角度についても正確に角度記録面への記録を行える。

【００３２】本発明の角度多重型のホログラム再生装置は上記課題を解決するために、複数の角度記録面のうち一つに基準角度記録面である旨を示す角度基準識別情報が記録されている角度多重型のホログラム記録媒体から記録情報を再生するホログラム再生装置であって、再生照明光を前記ホログラム記録媒体に照射する光源と、前記ホログラム記録媒体からの、前記再生照明光に基づく再生光を受光する受光手段と、該受光された再生光に基づいて、前記ホログラム記録媒体に重ねて記録された前

記複数の記録情報を夫々読み取る読取手段と、前記再生照明光に対する前記ホログラム記録媒体の再生角度を相対的に変更可能な再生角度変更手段と、前記再生角度を前記基準角度記録面に対応する基準再生角度を基準として所定角度ずつ変更させ且つ固定するように前記再生角度変更手段を制御する制御手段とを備えており、前記制御手段は、前記角度基準識別情報に基づいて前記再生角度変更手段を較正する。

【００３３】本発明の角度多重型のホログラム再生装置によれば、その動作時には、半導体レーザ装置等の光源は、レーザ光等の再生照明光を照射する。すると、例えばフォトダイオードアレイ、ＣＣＤ（Charge Coupled Device）等を含んでなる受光手段は、ホログラム記録媒体からの、再生照明光に基づく再生光を受光する。ここに「再生光」とは、記録時における参照光に対応する再生照明光がホログラム記録媒体に照射された際に生じる、０次光或いは１次光等の高次光などである。続いて、この受光手段により受光された再生光に基づいて、読取手段は、各角度記録面に記録された複数の記録情報を、角度記録面別に読み取る。

【００３４】この際特に、制御手段は、ホログラム記録媒体から読み取られる角度基準識別情報に基づいて、再生角度変更手段を較正する。そして、再生角度変更手段は、制御手段による制御下で、各再生角度を、基準再生角度を基準として所定角度ずつ変更し固定する。より具体的には例えば、今回再生する時点での再生角度変更手段における基準再生角度に対応する筈の機械的状態或いは光学系等の設定条件に対応する角度記録面と、角度基準識別情報により示される基準角度記録面との角度差を検出し、以降は、該検出された角度差だけオフセットを掛けて、再生角度変更手段は、再生角度を変更し固定する。これにより、最初に基準角度記録面に記録を行った他のホログラム記録装置及び今回記録を行おうとするホログラム再生装置間で、記録角度変更手段及び再生角度変更手段における機械的状態或いは光学系等の設定条件が一致していなくても、オフセットによりこのような差異が補償されて、今回再生を行おうとするホログラム再生装置により正確に記録情報の再生を行える。

【００３５】ここで比較のため、予め角度記録面別にその記録角度を示す角度情報をホログラム記録媒体に記録しておき、各角度記録面に対する再生を行う際に、該角度情報を先ず参照することで、角度変更の都度にいずれの角度記録面に対する再生を行うかを確認してから実際の再生を行う場合を想定する。この場合には、再生角度を変更する都度に、いずれの角度記録面であるかを確認する作業が発生するので、迅速なる再生動作は困難となる。

【００３６】これに対して、本発明のホログラム再生装置は、角度基準識別情報に基づいて較正を行うことで、その後の迅速なる角度変更と再生動作が可能となるのである。

【００３７】このように本発明によれば、角度多重により記録密度及び記録容量を飛躍的に高めることができ、しかも装置間のバラツキによらずに正確に角度多重型の再生を行うことができ、迅速なる再生動作も可能となる。

【００３８】加えて、上述した本発明の角度多重型のホログラム再生装置に対して、参照光の位相を変えて多重記録を行う参照光位相多重方式、参照光の振幅を変えて多重記録を行う参照光振幅多重方式、参照光の偏光を変えて多重記録を行う参照光偏光多重方式、及びホログラム記録媒体に入射する信号光の焦点深度を変えて多重記録を行う焦点深度多重方式のうち少なくとも一つの方式を組み合わせてもよい。これにより、一層高密度のホログラム再生が可能となる。

【００３９】本発明のホログラム再生装置の他の態様では、前記再生照明光の集光位置に対して、前記ホログラム記録媒体を相対的に移動させる移動手段を更に備える。

【００４０】この態様によれば、再生照明光が集光される一つの記録エリアに対する角度多重による一又は複数の角度記録面に対する再生が完了した際には、移動手段は、ホログラム記録媒体を相対的に移動させる。これにより、他の記録エリアに再生照明光が集光され、当該他の記録エリアに対して同様に複数の角度記録面に対する再生が行われる。

【００４１】この態様では、前記読取手段は、前記移動手段による移動毎に、前記ホログラム記録媒体の全ての角度記録面に対する再生を行うように構成してもよい。

【００４２】このように構成すれば、移動手段による移動の回数や移動量を小さく抑えることが可能となる。更に、移動手段による移動に伴って発生し得る、再生角度変更手段及び光学系等の機械的状態或いは設定条件における変化を最小限に抑えることも可能となる。

【００４３】尚、一の記録エリアにおける全ての角度記録面に対する再生を完了する前に、移動手段による移動を行ってもよい。或いは、一の記録エリアにおける一の角度記録面に対する再生を完了する毎に、移動手段による移動を行うことも可能である。

【００４４】本発明の角度多重型のホログラム記録方法は上記課題を解決するために、光源光を照射する光源と、該照射される光源光を信号光及び参照光に分離する第１光学系と、前記信号光の光路に配置されており前記信号光を変調可能な空間光変調器と、該空間光変調器を通過した信号光と前記参照光とをホログラム記録媒体上に導く第２光学系と、前記信号光及び前記参照光に対する前記ホログラム記録媒体の記録角度を相対的に変更可能な記録角度変更手段とを備えた角度多重型のホログラム記録装置によるホログラム記録方法であって、前記ホログラム記録媒体における複数の角度記録面のうち特定

の角度記録面を記録する際の前記記録角度を基準記録角度として設定する工程と、以降における前記記録角度を前記設定された基準記録角度を基準として所定角度ずつ変更し固定するように前記記録角度変更手段を制御する工程とを備える。

【００４５】本発明の角度多重型のホログラム記録方法によれば、上述した本発明のホログラム記録装置の場合と同様に、角度多重により記録密度及び記録容量を飛躍的に高めることができ、しかも装置間のバラツキによらずに正確に角度多重型の多重記録を行うことができ、迅速なる記録動作も可能となる。

【００４６】本発明の角度多重型のホログラム記録方法の一態様では、前記特定の角度記録面は、前記複数の角度記録面のうち最初に記録される角度記録面である。

【００４７】この態様によれば、ホログラム記録媒体における最初の角度記録面を記録する際の記録角度を基準記録角度として設定する。よって、最初の記録時に設定された基準記録角度を基準として、いずれの記録角度についても正確に角度記録面への記録を行える。

【００４８】本発明の角度多重型のホログラム再生方法は上記課題を解決するために、複数の角度記録面のうち一つに基準角度記録面である旨を示す角度基準識別情報が記録されている角度多重型のホログラム記録媒体から記録情報を再生するホログラム再生装置であって、再生照明光を前記ホログラム記録媒体に照射する光源と、前記ホログラム記録媒体からの、前記再生照明光に基づく再生光を受光する受光手段と、該受光された再生光に基づいて、前記ホログラム記録媒体に重ねて記録された前記複数の記録情報を夫々読み取る読取手段と、前記再生照明光に対する前記ホログラム記録媒体の再生角度を相対的に変更可能な再生角度変更手段とを備えた角度多重型のホログラム再生装置によるホログラム再生方法において、前記角度基準識別情報に基づいて前記再生角度変更手段を較正する工程と、前記再生角度を前記基準角度記録面に対応する基準再生角度を基準として所定角度ずつ変更させ且つ固定するように前記再生角度変更手段を制御する工程とを含む。

【００４９】本発明の角度多重型のホログラム再生方法によれば、上述した本発明のホログラム再生装置の場合と同様に、角度多重により記録密度及び記録容量を飛躍的に高めることができ、しかも装置間のバラツキによらずに正確に角度多重型の再生を行うことができ、迅速なる再生動作も可能となる。

【００５０】本発明のこのような作用及び他の利得は次に説明する実施の形態から明らかにされよう。

【００５１】

【発明の実施の形態】以下、本発明の実施の形態を図面に基づいて説明する。

【００５２】（ホログラム記録装置の第１実施形態）本発明のホログラム記録装置の第１実施形態について図１から図３を参照して説明する。

【００５３】先ず、図１及び図２を参照して、本実施形態に係るホログラム記録装置の全体構成について説明する。ここに、図１は、本実施形態に係るホログラム記録装置の全体構成を示すブロック図である。図２は、本実施形態が備えた空間光変調器の図式的な外観斜視図である。

【００５４】図１に示すように、本実施形態に係るホログラム記録装置１００は、レーザ光からなる光源光Ｌ０を照射する光源の一例たるレーザ装置１１と、この光源光Ｌ０を信号光Ｌ１及び参照光Ｌ２に分離する第１光学系の一例たるビームスプリッタ１２と、信号光Ｌ１の光路に配置され、信号光Ｌ１の径を拡大する拡大光学系の一例を構成するレンズ１３と、レンズ１３から出射された信号光Ｌ１を概ね平行光とするコリメータレンズ等のレンズ１４と、レンズ１４から出射された信号光Ｌ１を、記録すべき記録信号に応じて変調し、変調後の信号光Ｌ３として出射する空間光変調器１５と、信号光Ｌ３の径を縮小して、ホログラム記録媒体２００に向けて出射する縮小光学系の一例たるレンズ１６とを備える。

【００５５】更にホログラム記録装置１００は、ビームスプリッタ１２により分離された参照光Ｌ２を、ホログラム記録媒体２００上における、当該参照光Ｌ２に対応する信号光Ｌ３が集光される位置と同一位置に導く、第２光学系の一例たるミラー１７を備える。

【００５６】尚、図１では、ホログラム記録媒体２００上における、空間光変調器１５により回折されてなる、０次光及び４つの１次光を含む信号光Ｌ３が集光される表面部分Ｃ１を拡大して示してある。

【００５７】図２に示すように、空間光変調器１５は、例えば液晶装置からなり、複数のセル１５２に分割されており、該セル１５２の単位で変調可能である。例えば、空間光変調器１５が、アクティブマトリクス駆動型の液晶装置であれば、マトリクス状に２次元配列された複数の画素電極に対応して複数のセル１５２が規定される。空間光変調器１５は、セル１５２のサイズに応じた回折現象によって、信号光Ｌ１が入射されると、０次光Ｌ３－０及び１次光３－１、２次光Ｌ３－２、…の高次光を含む変調した回折光からなる信号光Ｌ３を出射するように構成されている。

【００５８】再び図１において、ホログラム記録装置１００は、ホログラム記録媒体２００の表面に対する信号光Ｌ３及び参照光Ｌ２の角度を、僅かずつ変更し且つ固定可能な記録角度変更装置１９と、信号光Ｌ３がホログラム記録媒体２００における記録すべき角度記録面に対応する記録角度となるように記録角度変更装置１９を制御する制御装置１８とを備える。尚、本実施形態では、信号光Ｌ３の光軸がホログラム記録媒体２００の表面に対してなす角度を“記録角度”として定義する。

【００５９】記録角度変更装置１９は、ホログラム記録

媒体２００の表面に対する信号光Ｌ３の記録角度を相対的に変更すればよく、例えば、光学系をなすレーザ装置１１、ビームスプリッタ１２、レンズ１３、１４及び１６、並びに空間光変調器１５の各光軸に対する角度や配置を変更するように構成されてもよいし、この光学系に対して、信号光Ｌ３や参照光Ｌ２の角度を変更する専用の光学要素を追加配置してもよい。或いは、これに代えて又は加えて、ホログラム記録媒体２００の保持角度を機械的に変更するように構成されてもよい。係る記録角度変更装置１９による角度変更動作については、制御装置１８により、後述する一連の記録動作の一部をなすように制御される。

【００６０】制御装置１８は、例えば、マイクロプロセッサからなるコントローラ等を含んでなり、ホログラム記録媒体２００上に記録すべき記録情報等に応じて制御信号Ｓ１を生成出力し、上述の如く記録角度変更装置１９における記録角度の制御を行うと共に、空間光変調器１５に対して記録情報に応じた記録信号Ｓｄを供給し、空間光変調器１５における変調の制御を行うように構成されている。

【００６１】ホログラム記録装置１００は更に、ホログラム記録媒体２００からの、再生照明光に基づく再生光Ｌ１２を集光するレンズ２４ａと、該レンズ２４ａを介して再生光Ｌ１２を受光する受光装置２５ａと、該受光された再生光Ｌ１２に基づいて、即ち受光装置２５ａから出力される受光信号Ｓｒに基づいて、ホログラム記録媒体２００に重ねて記録された複数の記録情報を夫々読み取る読取装置２６ａとを備える。

【００６２】本実施形態では、信号光Ｌ１又はＬ３をホログラム記録媒体２００に至る前のいずれかの段階で遮断することによって、参照光Ｌ２を、そのまま再生照明光として利用するように構成されている。例えば、制御装置１８による制御下で、空間光変調器１５を、信号光Ｌ１を遮断するシャッターとして用いることで、このように信号光Ｌ１又はＬ３を遮断できる。或いは、信号光Ｌ１又はＬ３を遮断するために専用の光学要素を信号光Ｌ１又はＬ３の光路に追加配置する構成や、遮光部材を信号光Ｌ１又はＬ３の光路に選択的に挿入する構成を採用してもよい。

【００６３】このようにして生成される再生光Ｌ１２をレンズ２４ａを介して受光する受光装置２５ａは、例えばフォトダイオードアレイ、ＣＣＤ（Charge Coupled Device）等を含んでなる。

【００６４】読取装置２６ａは、受光された再生光Ｌ１２の明暗パターンに対応する記録情報を特定することで、各記録情報を読み取る。本実施形態では特に、読取装置２６ａは、ホログラム記録媒体２００における複数の角度記録面のうち、基準記録角度に対応する基準角度記録面である旨を示す識別情報の一例としての、角度基準信号Ｓａが書き込まれた基準角度記録面から、当該角度基準信号Ｓａを読み取り可能である。そして、読取装置２６ａは、このように角度基準信号Ｓａを読み取ると、これを制御装置１８に出力するように構成されている。

【００６５】本実施形態では特に、制御装置１８は、ホログラム記録媒体２００における特定の角度記録面として最初の角度記録面を記録する際の記録角度を基準記録角度として設定する。そして、記録角度変更装置１９は、制御装置１８による制御下で、最初の角度記録面を記録した以降における記録角度を、この設定された基準記録角度を基準として、所定角度ずつ変更し固定するように構成されている。

【００６６】更に、制御装置１８は、読取装置２６ａからの角度基準信号Ｓａの有無によってホログラム記録媒体２００が未記録であると判定される場合、最初の角度記録面を基準角度記録面として設定するのに加えて、この最初の角度記録面に対して、基準記録角度に対応する基準角度記録面である旨を示す角度基準信号Ｓａを記録するように空間光変調器１５を制御する。その後は、この角度基準信号Ｓａに基づいて、ホログラム記録媒体２００に対して既に基準記録角度が設定されていることが容易に認識できる。更に、読取装置２６ａを用いて、いずれの角度記録面が基準角度記録面であるかを、ホログラム記録媒体２００の異同或いはホログラム記録装置１００の異同を問わずに容易に識別できる。

【００６７】更にまた、制御装置１８は、最初の角度記録面に対して記録情報が記録された後におけるホログラム記録媒体２００に対しては、角度基準信号Ｓａにより示される基準記録角度に基づいて記録角度変更装置１９を較正する。即ち、最初の角度記録面を記録する際には、これを基準角度記録面として設定すると共に記録角度変更装置１９に較正をかけないものとする。そして後に、任意の角度記録面を記録する際には、角度基準信号Ｓａにより示される基準角度記録面に対応する基準記録角度に応じて、記録角度変更装置１９に較正をかけるように構成されている。より具体的には例えば、今回記録する時点での記録角度変更装置１９における基準記録角度に対応する筈の機械的状態或いは光学系等の設定条件での記録角度と、角度基準信号Ｓａにより示される基準角度記録面に対応する基準記録角度との角度差を検出する。更に、この検出された角度差だけ、オフセットを掛けて、記録角度変更装置１９は、記録角度を変更するように構成されている。

【００６８】更にまた、別のホログラム記録装置によって当初からこのような角度基準信号Ｓａがホログラム記録媒体２００に記録されている場合にも、制御装置１８は、同様に、この角度基準信号Ｓａにより示される基準記録角度に基づいて、記録角度変更装置１９を較正するように構成されている。

【００６９】加えて、ホログラム記録装置１００は、信

号光Ｌ３及び参照光Ｌ２が集光される位置を、ホログラム記録媒体２００の表面に対して相対的に、その表面に沿った方向に移動させる移動装置２０を更に備えている。移動装置２０は、例えば、レンズ１６等の光学系の角度や配置を変更することにより、信号光Ｌ３及び参照光２の集光位置を移動させる。或いは、レーザ装置１１等の他の光学要素の角度や配置を変更することで移動してもよいし、このような移動のために専用の光学要素（例えば、設置角度が可変であるミラー等）を、信号光Ｌ１又はＬ３並びに参照光Ｌ２の光路に追加配置してもよい。更には、ホログラム記録媒体２００の保持機構により、ホログラム記録媒体２００自体をその表面に沿って機械的に移動させる機構を含んでもよい。係る移動装置２０による移動動作についても、制御装置１８で生成出力される制御信号Ｓ２によって、後述する一連の記録動作の一部をなすように制御される。

【００７０】次に、図１を参照して、以上の如く構成された本実施形態のホログラム記録装置１００の基本的な記録動作について説明する。

【００７１】その動作時には、レーザ装置１１は、光源光Ｌ０を照射し、ビームスプリッタ１２は、光源光Ｌ０を、信号光Ｌ１及び参照光Ｌ２に分離する。そして、信号光Ｌ１は、レンズ１３及び１４により空間光変調器１５のサイズに応じた径とされて、空間光変調器１５に入射される。すると、空間光変調器１５は、制御装置１８による制御下で、記録すべき複数の記録情報の各々に応じて、各セル１５２を変調単位として、信号光Ｌ１に対する変調を行う。その後、この変調された信号光Ｌ３は、レンズ１６で集光された後、ミラー１７で反射された参照光Ｌ２と共にホログラム記録媒体２００の記録領域に照射される。すると、これらの光は相互に干渉して、記録すべき記録情報が波面としてホログラム記録される。

【００７２】以上の基本的な記録動作によって、信号光Ｌ３及び参照光Ｌ２が一時に照射される一つの記録エリアにおける、一つの記録角度に対応する一つの角度記録面に対する記録情報の記録が行われる。

【００７３】次に、このような記録を、複数の角度記録面に対して行い、更に複数の記録エリアに対して行う、本実施形態のホログラム記録装置１００における角度多重型の記録動作の詳細について図３を参照して説明する。ここに、図３は、係る記録動作を示すフローチャートである。

【００７４】図３において、先ず信号光Ｌ３が遮断されると共に参照光Ｌ２が再生照明光として用いられて、再生光Ｌ１２が受光装置２５ａで受光される。これに応じて、読取装置２６ａから出力される角度基準信号Ｓａが制御装置１８によりチェックされる（ステップＳ１１）。そして、角度基準信号Ｓａの存否に応じて、当該ホログラム記録媒体２００に対する最初の記録であるか否かが制御装置１８により判定される（ステップＳ１２）。

【００７５】ここで、最初の記録であれば（ステップＳ１２：Ｙｅｓ）、信号光Ｌ３及び参照光Ｌ２が用いられると共に、角度基準信号Ｓａを示す記録信号Ｓｄに基づいて空間光変調器１５による変調動作が行われて、角度基準信号Ｓａが記録される。この記録は、ホログラム記録媒体２００における、この時点での角度記録面、即ち基準角度記録面に対して行われる（ステップＳ１３）。

【００７６】他方、ステップＳ１２の判定の結果、最初の記録でなければ（ステップＳ１２：Ｎｏ）、記録角度変更装置１９により固定されている現時点における記録角度がチェックされると共に、例えば制御装置１８の内蔵メモリに保持される（ステップＳ１４）。更に、角度基準信号Ｓａにより示される基準角度記録面に対応する基準記録角度と、この固定された状態における記録角度との角度差に基づいて記録角度変更装置１９に対する較正が行われる（ステップＳ１５）。この較正は、例えば記録角度変更装置１９に入力される制御信号Ｓ１に対して、上述の角度差に応じたオフセットをかけることで行われる。

【００７７】ステップＳ１３又はＳ１５の処理に続いて、移動装置２０により固定されたホログラム記録媒体２００の現時点での記録エリア（即ち、信号光Ｌ３及び参照光Ｌ２が現時点で照射される領域）における、記録角度変更装置１９により固定された現時点の角度記録面に対して、記録情報のデータ記録を行うか否かが制御装置１８により、判定される（ステップＳ１６）。

【００７８】ここで、データ記録を行なわない場合には（ステップＳ１６：Ｎｏ）、そのまま処理を終了する。即ち、この場合には、角度基準信号Ｓａのチェック（ステップＳ１１）や角度基準信号Ｓａの記録（ステップＳ１３）等については有効に実行されたことになる。

【００７９】他方、ステップＳ１６の判定の結果、データ記録を行なう場合には（ステップＳ１６：Ｙｅｓ）、信号光Ｌ３及び参照光Ｌ２が照射されると共に、記録信号Ｓｄに応じて空間光変調器１５により信号光Ｌ３が変調されて、実際のデータ記録が行われる（ステップＳ１７）。

【００８０】続いて、移動装置２０により固定されたホログラム記録媒体２００の現時点での記録エリアにおける、記録角度変更装置１９により変更可能な次の角度記録面に対して、記録情報のデータ記録を行うか否かが制御装置１８により、判定される（ステップＳ１８）。

【００８１】ここで、次の角度記録面に対してデータ記録を行なう場合には（ステップＳ１８：Ｙｅｓ）、制御信号Ｓ１による制御を受けて記録角度変更装置１９により、記録角度が所定の微小角度（例えば、０．０１度）だけ変更される（ステップＳ１９）。この際、前述の如く、記録角度変更装置１９においては、基準記録角度を

基準とした較正が行われているので、このような記録角度の変更を正確に行うことが可能である。そして、ステップＳ１６に戻って、以降の処理が繰り返される。

【００８２】他方、ステップＳ１８の判定の結果、次の角度記録面に対してデータ記録を行なわない場合には（ステップＳ１８：Ｎｏ）、移動装置２０により移動可能な他の記録エリアに対して、記録情報のデータ記録を行うか否かが制御装置１８により、判定される（ステップＳ２０）。

【００８３】ここで、他の記録エリアに対してデータ記録を行なう場合には（ステップＳ２０：Ｙｅｓ）、制御信号Ｓ１による制御を受けて記録角度変更装置１９により変更し固定する記録角度がリセットされる。即ち、次の記録エリアにおける最初の角度記録面に対応する記録角度となるように、記録角度変更装置１９により記録角度が変更され固定される（ステップＳ２１）。この際、前述の如く、記録角度変更装置１９においては、基準記録角度を基準とした較正が行われているので、このような記録角度のリセットを正確に行うことが可能であり、更にリセット後における記録角度の変更も正確に行うことも可能である。

【００８４】続いて、制御信号Ｓ２による制御を受けて移動装置２０により、信号光Ｌ３及び参照光Ｌ２が照射される領域が、所定距離だけ移動されて、他の記録エリアとされる（ステップＳ２２）。そして、ステップＳ１６に戻って、以降の処理が繰り返される。

【００８５】他方、ステップＳ２０の判定の結果、他の記録エリアに対してデータ記録を行なわない場合には（ステップＳ２０：Ｎｏ）、一連の記録処理を終了する。

【００８６】以上により、複数の記録エリアにおける、複数の角度記録面に対する記録情報の多重記録が完了する。

【００８７】以上説明したように本実施形態によれば、制御装置１８は、ホログラム記録媒体２００における最初の角度記録面を記録する際の記録角度を基準記録角度として設定する。そして、記録角度変更装置１９は、制御装置１８による制御下で、最初の角度記録面を記録した以降における記録角度を、この設定された基準記録角度を基準として、所定の微小角度ずつ変更し固定する。よって、ホログラム記録装置１００側、即ち記録角度変更装置１９、並びにレーザ装置１１、ビームスプリッタ１２、レンズ１３、１４及び１６からなる光学系等の機械的状態或いは設定条件で規定される基準記録角度に対応する筈の記録角度と、ホログラム記録媒体２００側における基準記録角度とを、最初の記録時に一致させることが可能となる。即ち、これら両角度を、同一機種であり且つ別のホログラム記録装置１００のいずれを使用する場合にも、装置間のバラツキによらずに一致させることが可能となる。しかもそれ以降は、基準記録角度を基準として、いずれの記録角度についても迅速且つ正確に角度記録面への記録を行える。

【００８８】以上説明したように本実施形態のホログラム記録装置１００は、角度多重型のホログラム記録が可能である。但し、本実施形態では、信号光Ｌ１又はＬ３を、遮断すると共に参照光Ｌ２を再生照明光として利用することによって、レンズ２４ａ、受光装置２５ａ及び読取装置２６ａを用いて、ホログラム記録媒体２００に角度多重方式で多重記録された任意の記録情報を再生することも可能である。即ち、図１に示した第１実施形態の構成において、記録時と再生時とで、信号光Ｌ１又はＬ３を遮断し、且つレンズ２４ａ、受光装置２５ａ、読取装置２６ａ及び制御装置１８によって、後述する本発明のホログラム再生装置と同様の再生動作を行うようにすれば、本実施形態のホログラム記録装置１００は、記録及び再生の両方が可能であるホログラム記録再生装置として構築することができる。

【００８９】以上説明した実施形態では、空間光変調器１５は、信号光Ｌ３を、記録情報の示す２値データに応じて２値変調してもよいし、記録情報の示す階調データに応じて多値変調することも可能である。

【００９０】尚、ホログラム記録媒体の材料としては、公知の無機系の材料でもよいし、有機系の材料（ポリマー材料）でもよい。また、ホログラム記録媒体は、カード状媒体として構成してもよいし、ディスク状媒体として構成してもよい。

【００９１】（ホログラム記録装置の第２実施形態）本発明のホログラム記録装置の第２実施形態について図４を参照して説明する。ここに図４は、第２実施形態のホログラム記録装置における記録動作を示すフローチャートである。

【００９２】第２実施形態では、角度記録面の変更と記録エリアの変更とのタイミングが、第１実施形態の場合と異なり、その他の構成及び動作については、第１実施形態の場合と同様である。そこで、図４のフローチャートでは、図３に示したステップと同様のステップには同様のステップ番号を付し、それらの説明については適宜省略する。

【００９３】図４において先ず、ステップＳ１１からＳ１７の処理が、図３に示した第１実施形態の場合と同様に行われる。

【００９４】ステップＳ１７の終了後に、移動装置２０により移動可能な他の記録エリアに対して、記録情報のデータ記録を行うか否かが制御装置１８により、判定される（ステップＳ３１）。

【００９５】ここで、他の記録エリアに対してデータ記録を行なう場合には（ステップＳ３１：Ｙｅｓ）、制御信号Ｓ２による制御を受けて移動装置２０により、信号光Ｌ３及び参照光Ｌ２が照射される領域が、所定距離だけ移動されて、他の記録エリアとされる（ステップＳ３

３）。そして、ステップＳ１６に戻って、以降の処理が繰り返される。

【００９６】他方、ステップＳ３１の判定の結果、他の記録エリアに対してデータ記録を行なわない場合には（ステップＳ２０：Ｎｏ）、移動装置２０により固定されたホログラム記録媒体２００の現時点での記録エリアにおける、記録角度変更装置１９により変更可能な次の角度記録面に対して、記録情報のデータ記録を行うか否かが制御装置１８により、判定される（ステップＳ３４）。

【００９７】ここで、次の角度記録面に対してデータ記録を行なう場合には（ステップＳ３４：Ｙｅｓ）、制御信号Ｓ１による制御を受けて記録角度変更装置１９により、記録角度が所定の微小角度（例えば、０．０１度）だけ変更される（ステップＳ３５）。この際、前述の如く、記録角度変更装置１９においては、基準記録角度を基準とした較正が行われているので、このような記録角度の変更を正確に行うことが可能である。そして、ステップＳ１６に戻って、以降の処理が繰り返される。

【００９８】他方、ステップＳ３４の判定の結果、次の角度記録面に対してデータ記録を行なわない場合には（ステップＳ３４：Ｎｏ）、一連の記録処理を終了する。

【００９９】以上により、複数の記録エリアにおける、複数の角度記録面に対する記録情報の多重記録が完了する。

【０１００】以上説明したように本実施形態によれば、制御装置１８は、ホログラム記録媒体２００における最初の角度記録面を記録する際の記録角度を基準記録角度として設定する。そして、記録角度変更装置１９は、制御装置１８による制御下で、最初の角度記録面を記録した以降における記録角度を、この設定された基準記録角度を基準として、所定の微小角度ずつ変更し固定する。よって、第１実施形態の場合と同様に、ホログラム記録装置１００側の機械的状態或いは設定条件で規定される基準記録角度に対応する筈の記録角度と、ホログラム記録媒体２００側における基準記録角度とを、最初の記録時に一致させることが可能となる。

【０１０１】（ホログラム記録装置の変形形態）尚、上述の各実施形態に対して、参照光Ｌ２の位相を変えて多重記録を行う参照光位相多重方式を、上述した本実施形態における角度多重方式に組み合わせてもよい。この場合、例えば、位相偏光用の光学要素を参照光Ｌ２の光路に配置して、参照光Ｌ２の位相を変更して、この位相別に同一記録領域に対して重ねて上記同様のホログラム記録を行えばよい。

【０１０２】更に、このような参照光位相多重方式に代えて又は加えて、参照光Ｌ２の振幅を変えて多重記録を行う参照光振幅多重方式を組み合わせてもよい。この場合、例えば、振幅変更用の光学要素を参照光Ｌ２の光路に配置して、参照光Ｌ２の振幅を変更して、この振幅別に、同一記録領域に対して重ねて上記同様のホログラム記録を行えばよい。

【０１０３】更に、このような参照光位相多重方式或いは参照光振幅多重方式に代えて又は加えて、参照光Ｌ２の偏光状態を変えて多重記録を行う参照光偏光多重方式を、上述した本実施形態における角度多重方式に組み合わせてもよい。この場合、例えば、偏光状態変更用の光学要素を参照光Ｌ２の光路に配置して、参照光Ｌ２の変更状態を変更して、この変更状態別に同一記録領域に対して重ねて上記同様のホログラム記録を行えばよい。

【０１０４】更に、このような参照光位相多重方式、参照光振幅多重方式或いは参照光偏光多重方式に代えて又は加えて、信号光Ｌ３の焦点深度を変えて多重記録を行う焦点深度多重方式を、上述した本実施形態における角度多重方式に組み合わせてもよい。この場合、例えば、レーザ装置１１或いはレンズ１３、１４、１６等の光学要素の位置を変更することで又は焦点距離変更用の光学要素を追加したり、ホログラム記録媒体２００側の位置を変更する機械要素を追加して、焦点深度を変更して、焦点深度別に同一記録領域に対して重ねて上記同様のホログラム記録を行えばよい。

【０１０５】これらの変形形態によれば、上述した実施形態と比べて、より高密度のホログラム記録が可能となる。

【０１０６】（ホログラム再生装置の実施形態）本発明のホログラム再生装置の実施形態について図５及び図６を参照して説明する。

【０１０７】先ず、図５を参照して、本実施形態に係るホログラム再生装置の全体構成について説明する。ここに、図５は、本実施形態に係るホログラム再生装置の全体構成を示すブロック図である。

【０１０８】本実施形態に係るホログラム再生装置３００は、上述した実施形態のホログラム記録装置１００により記録されたホログラム記録媒体２００から記録情報を読み出すものである。

【０１０９】図５に示すように、ホログラム再生装置３００は、再生照明光Ｌ１０をホログラム記録媒体２００に照射する、例えば半導体レーザ等の光源の一例たるレーザ装置２１と、再生照明光Ｌ１０をホログラム記録媒体２００に導くミラー２２及び２３と、ホログラム記録媒体２００からの、再生照明光に基づく再生光Ｌ１１を集光するレンズ２４と、該レンズ２４を介して再生光Ｌ１１を受光する受光装置２５と、該受光された再生光Ｌ１１に対応して受光装置２５から出力される受光信号Ｓｒに基づいてホログラム記録媒体２００に記録された記録情報を読み取る読取装置２６とを備える。

【０１１０】ホログラム再生装置３００は、ホログラム記録媒体２００の表面に対する再生照明光Ｌ１０の角度を、僅かずつ変更し且つ固定可能な再生角度変更装置２

９と、再生照明光Ｌ１０がホログラム記録媒体２００における再生すべき角度記録面に対応する再生角度となるように再生角度変更装置２９を制御する制御装置２８とを備える。尚、本実施形態では、再生照明光Ｌ１０の光軸がホログラム記録媒体２００の表面に対してなす角度を“再生角度”として定義する。

【０１１１】再生角度変更装置２９は、ホログラム記録媒体２００の表面に対する再生照明光Ｌ１０の再生角度を相対的に変更すればよく、例えば、光学系をなすレーザ装置２１、ミラー２２及び２３の各光軸に対する角度や配置を変更するように構成されてもよいし、この光学系に対して、再生照明Ｌ１０の角度を変更する専用の光学要素を追加配置してもよい。或いは、これに代えて又は加えて、ホログラム記録媒体２００の保持角度を機械的に変更するように構成されてもよい。係る再生角度変更装置２９による角度変更動作については、制御装置２８により、後述する一連の再生動作の一部をなすように制御される。

【０１１２】制御装置２８は、例えば、マイクロプロセッサからなるコントローラ等を含んでなり、ホログラム記録媒体２００から再生すべき記録情報等に応じて制御信号Ｓ１’を生成出力し、上述の如く再生角度変更装置２９における再生角度の制御を行うように構成されている。

【０１１３】このようにして生成される再生光Ｌ１１をレンズ２４を介して受光する受光装置２５は、例えばフォトダイオードアレイ、ＣＣＤ（Charge Coupled Device）等を含んでなる。

【０１１４】読取装置２６は好ましくは、受光装置２５の受光される明暗パターンと、ホログラム記録媒体２００を記録した際に空間光変調器１５（図１参照）によりセル単位で変調された複数の記録情報の値との関係をテーブルとしてメモリ内に格納しておく。そして、受光された再生光Ｌ１１の明暗パターンを特定し、このテーブルを参照して、特定された明暗パターンに対応する記録情報を特定することで、各記録情報を読み取る。従って、一の記録エリアにおける一の角度記録面に記録された複数の記録情報を同時に読み取れることになる。

【０１１５】本実施形態では特に、読取装置２６は、ホログラム記録媒体２００における複数の角度記録面のうち、角度基準信号Ｓａが書き込まれた基準角度記録面から、当該角度基準信号Ｓａを読み取り可能である。そして、読取装置２６は、このように角度基準信号Ｓａを読み取ると、これを制御装置２８に出力するように構成されている。

【０１１６】制御装置２８は、角度基準信号Ｓａに基づいて、いずれの角度記録面が基準角度記録面であるかを、ホログラム記録媒体２００の異同或いはホログラム再生装置３００の異同を問わずに容易に識別できる。

【０１１７】更に制御装置２８は、角度基準信号Ｓａにより示される基準記録角度に基づいて再生角度変更装置２９を較正する。即ち、任意の角度記録面を再生する際には、先ず角度基準信号Ｓａにより示される基準角度記録面に対応する基準再生角度に応じて、再生角度変更装置２９に較正をかけるように構成されている。より具体的には例えば、今回再生する時点での再生角度変更装置２９における基準再生角度に対応する筈の機械的状態或いは光学系等の設定条件での再生角度と、角度基準信号Ｓａにより示される基準角度記録面に対応する基準再生角度との角度差を検出する。更に、この検出された角度差だけ、オフセットを掛けて、再生角度変更装置２９は、再生角度を変更するように構成されている。

【０１１８】加えて、ホログラム再生装置３００は、再生照明Ｌ１０が集光される位置を、ホログラム記録媒体２００の表面に対して相対的に、その表面に沿った方向に移動させる移動装置３０を更に備えている。

【０１１９】移動装置３０は、例えば、ミラー２２及び２３等の光学系の角度や配置を変更することにより、再生照明光Ｌ１０の集光位置を移動させる。或いは、レーザ装置２１等の他の光学要素の角度や配置を変更することで移動してもよいし、このような移動のために専用の光学要素（例えば、設置角度が可変であるミラー等）を、再生照明光Ｌ１０の光路に追加配置してもよい。更には、ホログラム記録媒体２００の保持機構により、ホログラム記録媒体２００自体をその表面に沿って機械的に移動させる機構を含んでもよい。係る移動装置３０による移動動作についても、制御装置２８で生成出力される制御信号Ｓ２’によって、後述する一連の再生動作の一部をなすように制御される。

【０１２０】次に、図６を参照して、以上の如く構成された本実施形態のホログラム再生装置３００の基本的な再生動作について説明する。

【０１２１】その動作時には、レーザ装置２１は、ミラー２２及び２３を経て、再生照明光Ｌ１０をホログラム２００に照射する。すると、受光装置２５は、ホログラム記録媒体２００における、再生照明光Ｌ１０に基づく再生光Ｌ１１を受光する。ここに再生光Ｌ１１は、記録時における参照光に対応する再生照明光Ｌ１０がホログラム記録媒体２００に照射された際に生じる、０次光或いは１次光等の高次光などである。ホログラム記録の性質により、このような再生光Ｌ１１は、図１に示した変調された信号光Ｌ３と同様の明暗パターンを奏する。

【０１２２】続いて、この受光装置２５により受光された再生光Ｌ１１に基づいて、読取装置２６は、上述の如く高密度記録されたホログラム記録媒体２００に記録された各記録情報の再生が行われる。

【０１２３】以上の基本的な再生動作によって、再生照明光Ｌ１０が一時に照射される一つの記録エリアにおける、一つの再生角度に対応する一つの角度記録面に対する記録情報の再生が行われる。

【０１２４】次に、このような再生を、複数の角度記録面に対して行い、更に複数の記録エリアに対して行う、本実施形態のホログラム再生装置３００における角度多重型の再生動作の詳細について図６を参照して説明する。ここに、図６は、係る記録動作を示すフローチャートである。

【０１２５】図６において、先ず再生照明光Ｌ１０に基づく再生光Ｌ１１が受光装置２５で受光される。これに応じて、読取装置２６から出力される角度基準信号Ｓａが制御装置２８によりチェックされる（ステップＳ４１）。そして、再生角度変更装置２９により固定されている現時点における再生角度と、角度基準信号Ｓａにより示される基準角度記録面に対応する基準再生角度との角度差に基づいて再生角度変更装置２９に対する較正が行われる（ステップＳ４２）。この較正は、例えば再生角度変更装置２９に入力される制御信号Ｓ１’に対して、上述の角度差に応じたオフセットをかけることで行われる。

【０１２６】続いて、移動装置３０により固定されたホログラム記録媒体２００の現時点での記録エリアにおける、再生角度変更装置２９により固定された現時点の角度記録面に対して、記録情報のデータ再生を行うか否かが制御装置２８により、判定される（ステップＳ４３）。

【０１２７】ここで、データ再生を行なわない場合には（ステップＳ４３：Ｎｏ）、そのまま処理を終了する。即ち、この場合には、角度基準信号Ｓａのチェック（ステップＳ４１）等については有効に実行されたことになる。

【０１２８】他方、ステップＳ４３の判定の結果、データ再生を行なう場合には（ステップＳ４３：Ｙｅｓ）、再生照明光Ｌ１０が照射されて、受光装置２５及び読取装置２６等によって、実際のデータ再生が行われる（ステップＳ４４）。

【０１２９】続いて、移動装置３０により固定されたホログラム記録媒体２００の現時点での記録エリアにおける、再生角度変更装置２９により変更可能な次の角度記録面に対して、記録情報のデータ再生を行うか否かが制御装置２８により、判定される（ステップＳ４５）。

【０１３０】ここで、次の角度記録面に対してデータ再生を行なう場合には（ステップＳ４５：Ｙｅｓ）、制御信号Ｓ１’による制御を受けて再生角度変更装置２９により、再生角度が所定の微小角度（例えば、０．０１度）だけ変更される（ステップＳ４６）。この際、前述の如く、再生角度変更装置２９においては、基準再生角度を基準とした較正が行われているので、このような再生角度の変更を正確に行うことが可能である。そして、ステップＳ４３に戻って、以降の処理が繰り返される。

【０１３１】他方、ステップＳ４５の判定の結果、次の角度記録面に対してデータ再生を行なわない場合には（ステップＳ４５：Ｎｏ）、移動装置３０により移動可能な他の記録エリアに対して、記録情報のデータ再生を行うか否かが制御装置２８により、判定される（ステップＳ４７）。

【０１３２】ここで、他の記録エリアに対してデータ再生を行なう場合には（ステップＳ４７：Ｙｅｓ）、制御信号Ｓ１’による制御を受けて再生角度変更装置２９により変更し固定する再生角度がリセットされる。即ち、次の記録エリアにおける最初の角度記録面に対応する再生角度となるように、再生角度変更装置２９により再生角度が変更され固定される（ステップＳ４８）。この際、前述の如く、再生角度変更装置２９においては、基準再生角度を基準とした較正が行われているので、このような再生角度のリセットを正確に行うことが可能であり、更にリセット後における再生角度の変更も正確に行うことも可能である。

【０１３３】続いて、制御信号Ｓ２’による制御を受けて移動装置３０により、再生照明光Ｌ１０が照射される領域が、所定距離だけ移動されて、他の記録エリアとされる（ステップＳ４９）。そして、ステップＳ１６に戻って、以降の処理が繰り返される。

【０１３４】他方、ステップＳ４７の判定の結果、他の記録エリアに対してデータ再生を行なわない場合には（ステップＳ４７：Ｎｏ）、一連の再生処理を終了する。

【０１３５】以上により、複数の記録エリアにおける、複数の角度記録面に対する記録情報の再生が完了する。

【０１３６】以上説明したように本実施形態によれば、再生角度変更装置２９は、制御装置２８による制御下で、角度基準信号Ｓａにより示される基準角度記録面に対応する基準再生角度を基準として、所定の微小角度ずつ変更し固定する。よって、ホログラム再生装置３００側、即ち再生角度変更装置２９、並びにレーザ装置２１、ミラー２２及び２３からなる光学系等の機械的状態或いは設定条件で規定される基準再生角度に対応する筈の再生角度と、ホログラム記録媒体２００側における基準再生角度とを、最初の再生時に一致させることが可能となる。即ち、これら両角度を、同一機種であり且つ別のホログラム再生装置３００のいずれを使用する場合にも、装置間のバラツキによらずに一致させることが可能となる。しかもそれ以降は、基準再生角度を基準として、いずれの再生角度についても迅速且つ正確に角度記録面からの再生を行える。

【０１３７】本発明は、上述した実施形態に限られるものではなく、請求の範囲及び明細書全体から読み取れる発明の要旨或いは思想に反しない範囲で適宜変更可能であり、そのような変更を伴うホログラム記録装置及び方法並びにホログラム再生装置及び方法もまた本発明の技術的範囲に含まれるものである。

【０１３８】

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【発明の効果】以上詳細に説明したように本発明のホログラム記録装置及び方法並びにホログラム再生装置及び方法によれば、記録密度及び記録容量を向上させることが可能であり、しかも正確且つ迅速に記録動作や再生動作を行うことが可能である。

【図面の簡単な説明】

【図１】本発明のホログラム記録装置に係る第１実施形態の全体構成を示すブロック図である。

【図２】第１実施形態が備えた空間光変調器の図式的な外観斜視図である。

【図３】第１実施形態における角度多重型の記録動作を示すフローチャートである。

【図４】本発明のホログラム記録装置に係る第２実施形態における角度多重型の記録動作を示すフローチャートである。

【図５】本発明のホログラム再生装置に係る実施形態の全体構成を示すブロック図である。

【図６】本発明のホログラム再生装置に係る実施形態における角度多重型の再生動作を示すフローチャートである。

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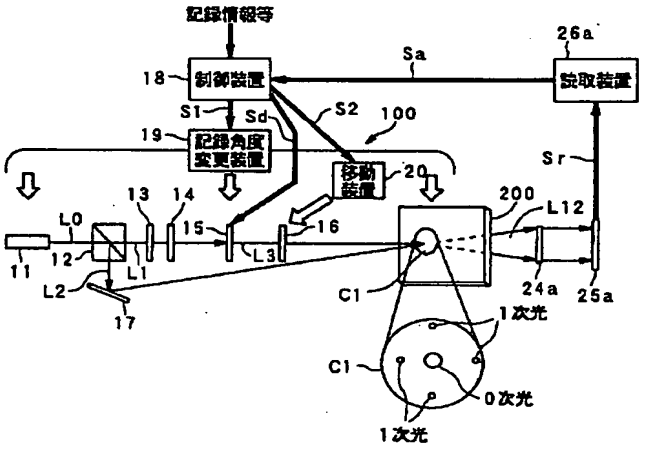
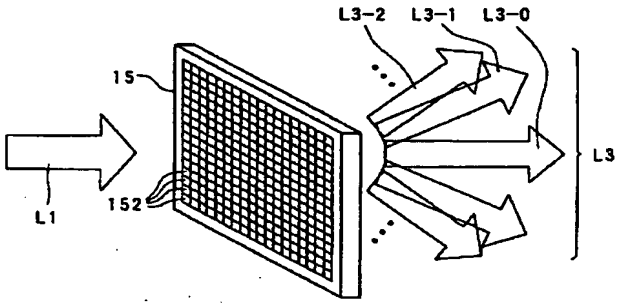
【符号の説明】

１１…レーザ装置
１２…ビームスプリッタ
１３、１４、１６…レンズ
１５…空間光変調器
１７…ミラー
１８…制御装置
１９…記録角度変更装置
２０…移動装置
２１…レーザ装置
２２、２３…ミラー
２４…レンズ
２５…受光装置
２６…読取措置
２８…制御装置
２９…記録角度変更装置
３０…移動装置
１００…ホログラム記録装置
２００…ホログラム記録媒体
３００…ホログラム再生装置

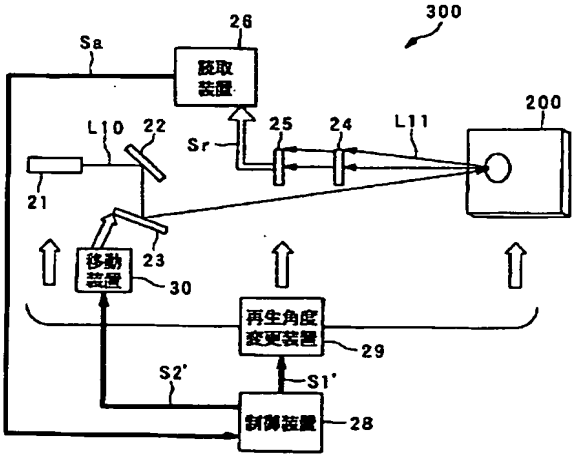
【図１】



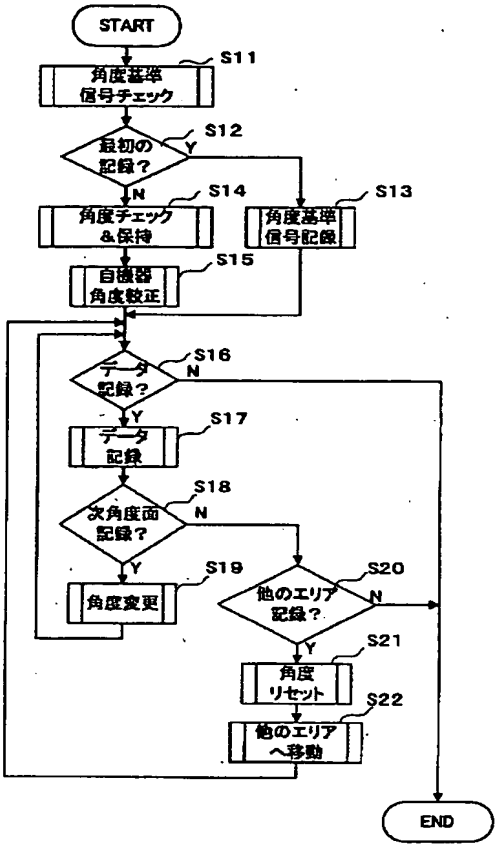
【図２】



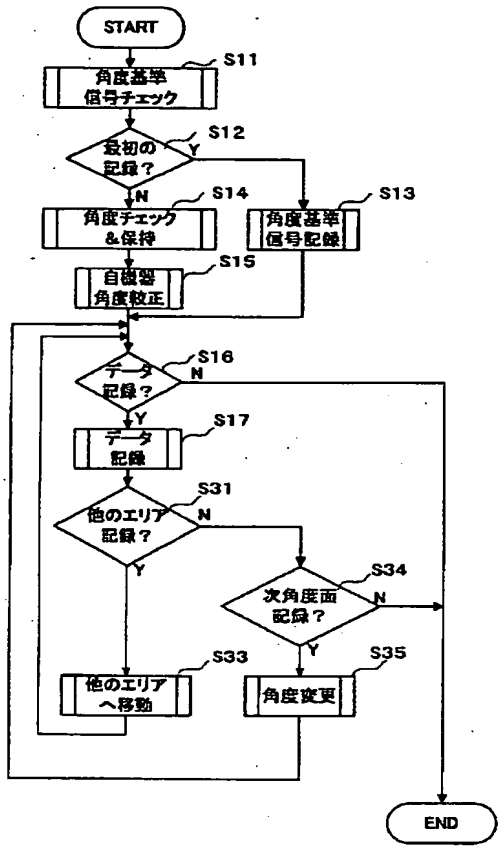
【図５】



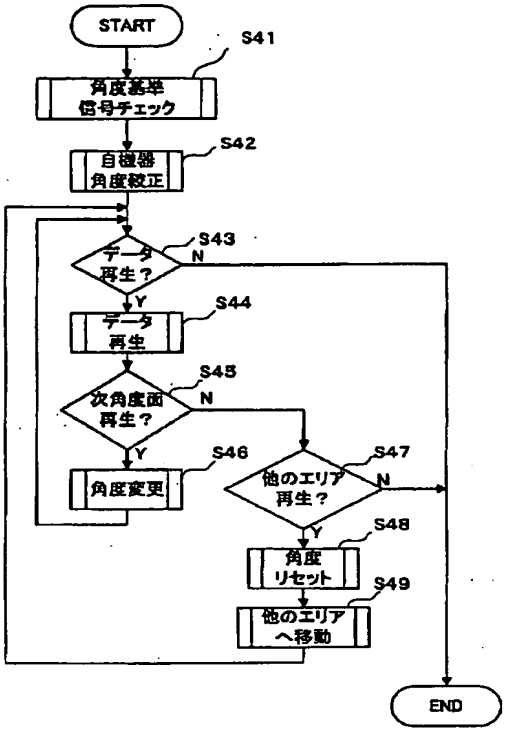
【図３】


START
S11
角度基準信号チェック
S12
最初の記録？
Y
N
S14
角度チェック&保持
S13
角度基準信号記録
S15
自機器角度較正
S16
データ記録？
N
Y
S17
データ記録
S18
次角度面記録？
N
Y
S19
角度変更
S20
他のエリア記録？
N
Y
S21
角度リセット
S22
他のエリアへ移動
END

【図４】


START
S11
角度基準信号チェック
S12
最初の記録？
Y
N
S14
角度チェック&保持
S13
角度基準信号記録
S15
自機器角度較正
S16
データ記録？
N
Y
S17
データ記録
S31
他のエリア記録？
N
Y
S34
次角度面記録？
N
Y
S33
他のエリアへ移動
S35
角度変更
END

【図６】



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